NASA HQ
TN-14-TM
333
P.51

NASA

National Aeronautics and
Space Administration

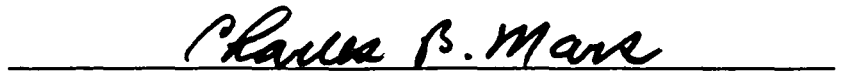
SPACE STATION FREEDOM FACILITIES REVIEW PANEL (FRP)

(NASA-TM-101758) SPACE STATION FREEDOM FACILITIES REVIEW PANEL (FRP) Final Report (NASA) 51 p
N91-70848
Unclas
00/14 0000333

FINAL REPORT

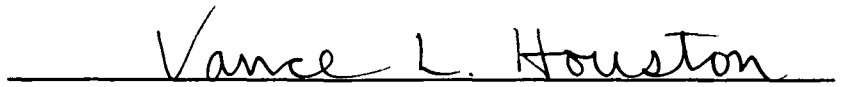
December, 1988

Prepared for



CHARLES B. MARS
Director, Ground Operations
and Logistics Division
Space Station Freedom Program Office
Utilization and Operations Group

by



VANCE L. HOUSTON
Engineer, Ground Operations
and Logistics Division
Space Station Freedom Program Office
Utilization and Operations Group

Approved by

JOHN T. COX
Director of Program Utilization and Operations
Space Station Freedom Program Office

TABLE OF CONTENTS

Page

LIST OF FIGURES iii

ACKNOWLEDGMENTS v

ABBREVIATIONS AND ACRONYMS vii

I. INTRODUCTION 1

A. Review History 1
B. Report Summary 1

II. FACILITIES OVERVIEW 5

A. Category Definitions 5
B. Facilities by Category 6

1. Software Development 6
2. Elements/Systems Development 8
3. Mock-ups/Simulators/Trainers 15
4. Health/Safety/Crew Productivity 16
5. Automation and Robotics Technology 17
6. Materials Technology 18
7. Ground and Space Operations 20

III. SPACE STATION FREEDOM ROLES AND RESPONSIBILITIES vs FACILITIES 23

IV. SPACE STATION FREEDOM FUNCTIONS vs FACILITIES 25

V. CONSTRUCTION OF FACILITIES 27

VI. OBSERVATIONS 31

VII. APPENDIX: FACILITIES CODE INDEX 33

LIST OF FIGURES

		Page
Figure 1	Space Station Freedom FRP Methodology	2
Figure 2	Space Station Freedom FRP Schedule	3
Figure 3	Space Station Freedom Roles & Responsibilities	Pocket/Back Cover
Figure 4	Space Station Freedom Functions vs Facilities	Pocket/Back Cover
Figure 5	Space Station Freedom CoF Program Plan	28

PAGE iii INTENTIONALLY BLANK

PRECEDING PAGE BLANK NOT FILMED

ACKNOWLEDGMENTS

The review of Space Station Freedom facilities/activities by the Facilities Review Panel (FRP) was a major undertaking that required the combined efforts of many individuals and organizations. Especially deserving of recognition are those individuals at the field Centers who did an outstanding job of briefing the FRP and making the site visits a memorable experience. Equally deserving of recognition are the participants and supporters shown below; to them we extend our thanks and our appreciation.

PARTICIPANTS IN THE FRP

LEVEL I

Wayne Richie	SO

LEVEL II

Charles Mars, Chairman	SSUG
William Adair	SSE
Kirstie Barkley	SSUG
Marc Bensimon	SS
Jack Bullman	SSUO
Melvin De Gree	SSI
Robert Dorian	SSUU
Vance Houston	SSUG
Paul Keith	SSUG
Bud Reynolds	SSE
Robert Soltess	SSB

LEVEL III

Richard Brown	ARC
Robert Buchan	LARC
Karen Clark	JSC
Scott Croomes	MSFC
John Dahlgren	JPL
John Kobak	LERC
John Oertel	KSC
Mona Tycz	GSFC

OTHER SUPPORTERS

Jerry Anderson	TADCORPS
Robert Brotherton	PSC
Steve Cavanaugh	NXF
Molly Dorman	PSC
Thomas O'Rourke	PSC
Tom Paradis	EER, Inc.
Jerry Reeve	PSC
Julie Rose	PSC
Robert Vipperman	PSC

PAGE IV INTENTIONALLY BLANK

PRECEDING PAGE BLANK NOT FILMED

ABBREVIATIONS AND ACRONYMS

ACCOM	Accommodation
ACD	Architectural Control Document
AC and S	Attitude Control and Stabilization
ADV	Advanced
APAE	Attached Payload Accommodations Equipment
A and R	Automation and Robotics
ARC	Ames Research Center
ASSY, ASSEM	Assembly
ATTCH	Attached
AUTO	Automated
BLDG	Building
C and T	Communications and Tracking
CDOF	Customer Data Operations Facility
CDR	Critical Design Review
CH	Chamber(s)
CNTR	Center
CoF	Construction of Facilities
COMP	Components
CSSL	Communications Systems Simulation Laboratory
CYBER	Control Data Corporation Computer Hardware
DDT&E	Design, Development, Test and Evaluation
DEF	Definition
DETERIOR	Deterioration
DEV	Development
DIST	Distribution
DMS	Data Management System
DOD	Department of Defense
ECLSS	Environmental Control and Life Support System
EDCO	Extended Duty Crew Operations
ELECT	Electrical
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMU	Extra-vehicular Mobility Unit
ENG	Engineering

PRECEDING PAGE BLANK NOT FILMED

PAGE vii INTENTIONALLY BLANK

ENVIRO	Environmental
EPS	Electrical Power System
EQUIP	Equipment
ESA	European Space Agency
ESC	Engineering Support Center
ESTL	Electronic Systems Test Laboratory
EVA	Extra-vehicular Activity
EVAL	Evaluation
EXT	External
FAC	Facility
FLT	Flight
FRP	Facilities Review Panel
FSE	Flight Support Equipment
FTS	Flight Telerobotic Servicer
GN and C	Guidance, Navigation and Control
GPS	Global Positioning System
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSPF	Goddard Software Production Facility
HAB	Habitation
HMF	Health Maintenance Facility
HQ	NASA Headquarters
HW	Hardware
INT, INTEG	Integration
ITVF	Integration, Test and Verification Facility
IVA	Intra-vehicular Activity
JEM	Japanese Experiment Module
JPL	Jet Propulsion Lab
JSC	Johnson Space Center
KHz	Kilohertz
KSC	Kennedy Space Center
KSPF	Kennedy Software Production Facility
LAB	Laboratory
LARC	Langley Research Center
LERC	Lewis Research Center
MAT	Materials

MDM	Module Distribution Mode
MGT	Management
MMU	Manned Maneuvering Unit
MNT	Maintenance
MRMDF	Mobile Remote Manipulator Development Facility
MSCS	Mobile Servicing Center System
MSFC	Marshall Space Flight Center
MSIF	Multi-systems Integration Facility
MT/PMP	Man-tended/Permanent Manned Presence
NASA	National Aeronautics and Space Administration
NASTRAN	NASA Structural Analysis
NBL	Neutral Buoyancy Laboratory
NIU	Network Interface Unit
OMA	Operations Management Application
OMS	Operations Management System
OMV	Orbital Maneuvering Vehicle
OPS	Operations
ORU	Orbital Replacement Unit
OTV	Orbital Transfer Vehicle
PCC	Platform Control Center
PDR	Preliminary Design Review
PLSS	Portable Life Support System
PMAD	Power Management and Distribution
PMMS	Process Materials Management System
POIC	Payload Operations Integration Center
POTF	Payload Operations Training Facility
PSF	Power Systems Facility
PV	Photovoltaic
PWR	Power
QUAL	Qualification
R and T	Research and Technology
RASSF	Robotics Assembly and Servicing Simulation Facility
RF	Radio Frequency
RFI	Radio Frequency Interference
SD	Solar Dynamics
SERV	Servicing

SES	Systems Engineering Simulator
SIM, SIMUL	Simulation
SPF	Software Production Facility
SS	Space Station
SSAIAF	Space Systems Automated Integration & Assembly Facility
SSCC	Space Station Control Center
SSDIF	Spacecraft Systems Development and Integration Facility
SSE	Software Support Environment
SSIS	Space Station Information System
SSMTF	Space Station Mock-up and Trainer Facility
SSPF	Space Station Processing Facility
SSTF	Space Station Training Facility
SUP	Support
SYS	Systems
TCS	Thermal Control System
TDRSS	Tracking and Data Relay Satellite System
TMIS	Technical and Management Information System
TTB	Thermal Test Bed
VAC	Vacuum
VAX	Digital Equipment Corporation Computer Hardware
VCM	Volatile Condensable Material
VER, VERIF	Verification
VLS	Vandenberg Launch Site
WETF	Weightless Environment Training Facility
WP-01	Work Package 1 (MSFC Major Space Station Freedom Development Contract)
WP-02	Work Package 2 (JSC Major Space Station Freedom Development Contract)
WP-03	Work Package 3 (GSFC Major Space Station Freedom Development Contract)
WP-04	Work Package 4 (LERC Major Space Station Freedom Development Contract)
WSTF	White Sands Test Facility

I. INTRODUCTION

A. REVIEW HISTORY

The Space Station Freedom Facilities Review Panel (FRP) was established by the Level II NASA Space Station Freedom Program Office to review projected facility DDT&E and operations support requirements and the associated operational costs. For this review, the "brick and mortar" definition of a facility was extended to include laboratories and test beds housed within multi-purpose facilities. The fundamental objective of the FRP was to define an optimal set of Space Station Freedom facilities/activities and a comprehensive facilities data base.

Charles Mars, Director of the Ground Operations and Logistics Division, Level II Program Office, chaired the review panel which included participants from the field Centers/Project Offices (Level III), the Space Station Freedom Program Office (Level II), and the Office of Space Station (Level I). Various scientific, engineering and managerial disciplines were represented; thereby enabling the review of funding and scheduling requirements as well as individual facility capabilities.

The commercial, university, work package contractors (contractors providing major Space Station Freedom hardware), and international partner facilities were excluded from the review. This exclusion allowed the panel to focus on NASA facilities that would be needed to support First Element Launch and subsequent operations and/or sustaining engineering activity. Some facilities/activities will be totally supported by the Space Station Freedom program while others will involve support from NASA organizations that are closely allied with the program.

The review began with a series of site visits that included in-depth briefings and facility tours. It was through these visits that the FRP became acquainted with all existing and planned facilities and acquired additional insight into the facility support requirements. In order to better understand the totality of the planned use of facilities, a tour of contractor facilities was conducted at McDonnell Douglas, Huntington Beach, CA. Boeing and Rocketdyne representatives also presented an overview of their program activities. Once the site visits were completed, the FRP conducted a preliminary assessment of each facility and documented its findings. Figures 1 and 2 summarize the review process and schedule.

It should be emphasized that, for certain of these facilities (see the Figure 3 fold-out), neither the Space Station Freedom Program Office nor the Centers have provided funding. Accordingly, the Centers' roles and responsibilities listed for some of these facilities are proposed rather than officially accepted by the program.

B. REPORT SUMMARY

This report is designed to do two things: (1) identify those NASA facilities that may be utilized in support of the Space Station Freedom program, thereby providing a consistent means of referencing facilities without any ambiguity about facility titles or which facility is being addressed during day-to-day program discussions; and (2) define the support that each facility provides for the development and operation of Space Station Freedom.

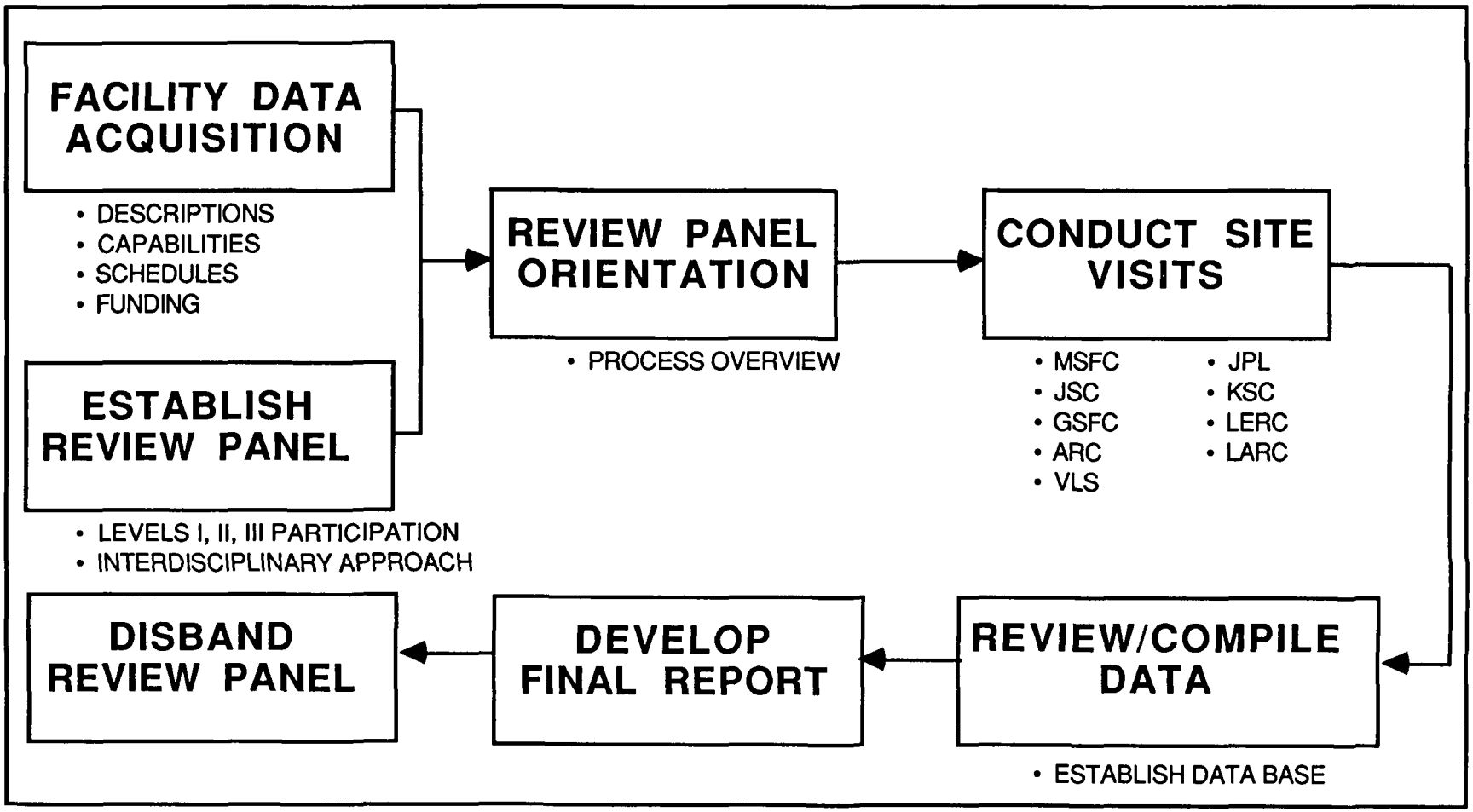


FIGURE 1 SPACE STATION FREEDOM FRP METHODOLOGY

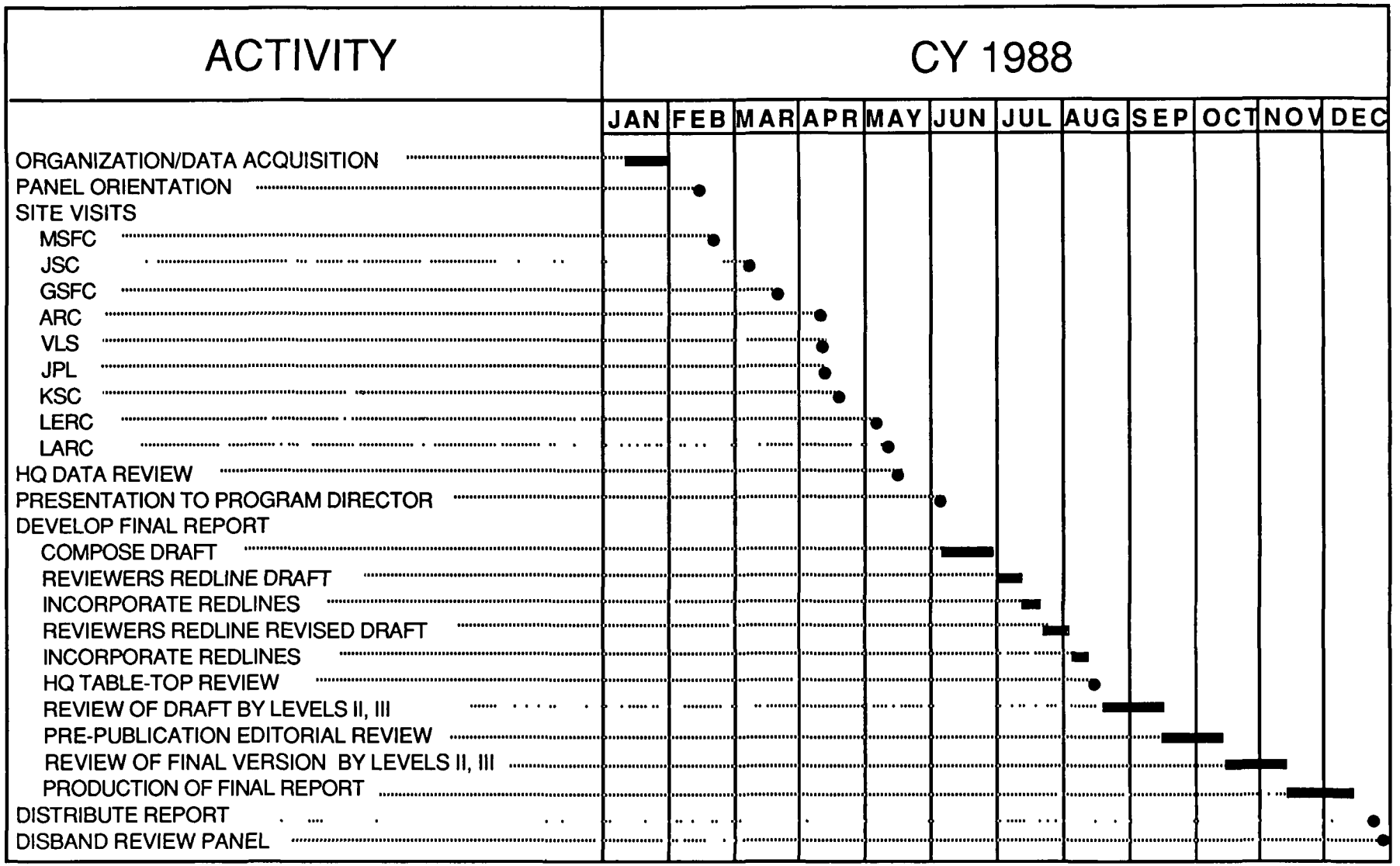


FIGURE 2 SPACE STATION FREEDOM FRP SCHEDULE

Section II identifies each facility by title and identification code. Because many facilities have similar titles, an identification code is used as a unique identifier. Facilities are grouped according to key program functions, and a brief description of each facility is provided.

Section III highlights the association between facilities and the program roles that have been assigned to each Center. Section IV describes the integration of facilities that result in the capability to perform ground-based operations or to develop hardware/software. Both Sections present the facility data in a chart format so that each chart may be used as a convenient reference tool.

The Construction of Facilities (CoF) requirements are presented in Section V. The prioritization and approval status of CoF projects are subject to circumstances beyond the direct control of the Space Station Freedom program; consequently, no attempt was made to show the CoF status of facilities that are presented in this report.

Section VI contains observations by the FRP. This report may be used to evaluate the facilities and requirements necessary to support the Space Station Freedom program. The FRP is encouraged by the interest shown in Space Station Freedom facilities and believes that this report will serve to exhibit these facilities in a manner that is both useful and productive.

II. FACILITIES OVERVIEW

A. CATEGORY DEFINITIONS

The facilities reviewed by the FRP covered a broad range of activities. Grouping facilities into categories that parallel key program functions eliminates some of the difficulty in understanding similarities between facilities and their interrelationships (although the assignment of a facility to a specific category was difficult in some cases because the function of that facility overlapped multiple categories). Accordingly, the following categories were defined:

SOFTWARE DEVELOPMENT: Facilities in this category are used for software production, verification, and software simulation for hardware design/development. The scope of development may include, for example, the Space Station Information System (SSIS), Operations Management System (OMS), Technical Management and Information System (TMIS), and Data Management System (DMS). The diversity in facility support ranges from simple code development to the simulation of distributed systems.

ELEMENTS/SYSTEMS DEVELOPMENT: Design, fabrication, integration and testing are the capabilities provided by facilities in this group. As expected, a large number of test beds are found here. Typical hardware development may include the modules, racks, truss structures, and distributed system components. The facilities are primarily geared toward development, as opposed to operations, although some may be required to support sustaining engineering.

MOCK-UPS/SIMULATORS/TRAINERS: There is considerable overlap in these three areas. For example, mock-ups, simulators, and trainers can be used for crew training and hardware development, and a simulator or trainer can contain several mock-ups. A mock-up refers to a simulator or trainer that has a fidelity that may vary from very low (simple volumetric representation only) to very high (fully operational, flight-like representation). The fidelity of a mock-up is dependent upon when, where, and how it will be used to support a particular activity (concept development, engineering evaluation, crew training, etc.). A simulator is usually a high fidelity mock-up driven by real-time computer(s) that enable demonstration of an exchange of resources and simulation of a particular environment. The common thread that ties this group together is the man-in-the-loop requirement which is necessary for the proof-of-concept and crew training functions. Note that many of these facilities support element/system development extensively as well as procedures development and training functions.

HEALTH/SAFETY/CREW PRODUCTIVITY: This category is just what the name implies. Facilities here are focused on enhancing the health, safety and productivity of the crew members. The emphasis is not on crew training, but advancing the state-of-the-art in human performance and fitness.

AUTOMATION AND ROBOTICS TECHNOLOGY: Research in this category has been going on for some time, mainly through the Space Station Freedom advanced development program. Many of the facility capabilities are concentrated on the Flight Telerobotic Servicer (FTS). Other capabilities are more generic in nature, aimed toward improving end-effectors and hand controllers. The grouping of facilities into this category instead of the Elements/Systems Development category was done because of the high visibility that automation and robotics

receives throughout NASA; thus making it easier to highlight facilities associated with A and R technology.

MATERIALS TECHNOLOGY: Facilities in this category are commonly used for materials investigation, selection and qualification. The capabilities represented here are basic to any development program. There is a distinct difference between this set of facilities and those placed within the Elements/Systems Development category. Materials technology facilities frequently make use of test specimens for analysis and testing. On the other hand, hardware development facilities often times utilize the entire component, complete with all parts and subassemblies. As with other development phase facilities, some may be required during mature operations to evaluate materials used in experiments, payloads, or Space Station Freedom upgrades/improvements.

GROUND AND SPACE OPERATIONS: This category emphasizes station operations and its ground support. Facilities included here will probably be required to support Space Station Freedom for the life of the program.

B. FACILITIES BY CATEGORY

The following is a listing of all facilities by name, with a facility Identification Code in brackets. The code consists of a Center identifier and a facility designation number. The Center identifiers are as follows:

Identifier	Center
A	ARC
G	GSFC
J	JSC
JPL	JPL
K	KSC
La	LARC
Le	LERC
M	MSFC

Each facility is assigned to one of the function categories defined in the previous section. A brief description is provided showing how each facility is used to support Space Station Freedom development and/or operations Locating facilities cross-referenced in the text is made easier through use of the Appendix on page 33. [The presence of an asterisk after a facility title indicates the use of Construction of Facilities funding.]

1. SOFTWARE DEVELOPMENT

Engineering Computation Facility - CYBER 830 and 840 * [J-19]: This facility will provide large code computational support to the engineering effort utilizing the CYBER 830 and 840 computer systems. This support includes NASTRAN analysis for structures; heat transfer and control systems analysis; plus math model development for DMS and a stand-alone, non-real-time station simulation. This facility also serves as host for the AC and S Test Bed (J-21).

Attitude Control and Stabilization (AC and S) Test Bed [J-21]: This laboratory will provide software models of proposed GN and C system components for early system definition and development. As flight hardware designs are finalized, the AC

and S math models will be updated. During operations phase, the AC and S Test Bed will support assembly through vehicle dynamic modeling. This same dynamic modeling capability will be required to support evolutionary growth of Space Station Freedom. Unlike the GN and C Emulator Test Bed (J-01), this test bed is off-line for batch mode processing and is required for computationally intense GN and C analysis.

Data Management System (DMS) Test Bed * [J-22]: This facility is a distributed high fidelity DMS Test Bed to functionally integrate participating JSC systems test beds. It will also provide data communication and connectivity with other test beds in the SSIS network such as ESA and GSFC and will support developmental work in technical areas such as OMA conceptual definition activities as well as critical hardware (e.g., NIU) development and evaluation. This integrated test bed will support the investigation and validation of fundamental engineering and operations DMS concepts for use on Space Station Freedom.

Systems Operations Development Laboratory [J-43]: This Lab supports ground operations software applications prototyping such as display and control, fault detection, procedures interpreter, systems management, training software prototyping (ground and on-board), and hardware/software technology assessments and trade-offs.

Multi-systems Integration Facility (MSIF) * [J-44]: The MSIF will establish a high fidelity program level integration facility for the Space Station Freedom program software to ensure developer systems are integrated, tested, and certified as flight ready. Products which will assist Space Station Freedom development are certified software flight loads and integrated software/hardware flight ready systems.

Software Support Environment (SSE) Development Facility * [J-45]: This facility will support the development and sustaining engineering for the Software Support Environment. The SSE, consisting of software life cycle tools, rules, and procedures, will be used across the program and through the life of the program for sustaining engineering of the Space Station Freedom program Operational Software System.

Goddard Software Production Facility (GSPF) * [G-09]: This GSFC facility, located in the Customer Data Operations Facility (CDOF), will provide support for the development and maintenance of WP-03 software. It will operate a subset of software tools supplied by the SSE and support the implementation rules developed by the SSE.

Platform Data Management System Test Bed [G-15]: The Platform DMS Test Bed will be used by the WP-03 contractor to: (1) evaluate modifications required to common JSC DMS components for application to platform DMS; (2) check hardware and software interfaces as they are breadboarded so they can be checked out functionally; (3) test bus access protocols and associated data latencies; (4) test limited layer data management protocols for functionality; and (5) determine the impact of data system architecture on platform subsystems (e.g., the effect upon GN and C Control Loops, Command Security Processing and mass storage considerations).

Electric Power System Simulation Lab [Le-07]: The Electrical Power System Simulation Lab will be used to conduct supporting development tests of power

system control software and to support the Software Integrated Test to be performed by the WP-04 contractor at LERC. This software includes power system control algorithms and power system simulation for PV, SD, and hybrid configurations. It also can be used in evaluating the ADA Department of Defense software language for real-time power system control algorithms.

Kennedy Software Production Facility (KSPF) [K-07]: This KSC facility will support software development for integration and checkout tests from prelaunch to postlanding. It will also allow software to be produced to check Shuttle/Space Station Freedom payload interfaces.

2. ELEMENTS/SYSTEMS DEVELOPMENT

WP-01 Manufacturing and Assembly Building [M-01]: The WP-01 contractor will utilize MSFC Building 4708 for manufacturing and assembly operations and for administrative offices. It will also provide for meteoroid shield fabrication; module structural assembly and checkout; rack assembly and integration; tube and duct fabrication; and module integration assembly and checkout (IACO).

Core Module Integration Facility * [M-02]: During the development phase of the program, the facility will support ECLSS component and system level testing. This includes subsystem/system simulations, enhancements of existing hardware, and interface verification. This facility will provide for flight support activities such as maintenance/verification of subsystems, new module/node interface verification, growth subsystem use validation, Space Station Freedom future missions, and the troubleshooting of anomalies occurring in the flight system during the operations phase.

Process Materials Management System (PMMS) [M-03]: This facility supports the development testing of the Process Materials Management System , a subsystem of the U. S. Lab Module. The hazardous nature of the system operation is a key facility consideration. Tasks include, but are not limited to, development and test of safety operations/procedures; chemical and microbial assessments; data reduction and reporting; materials and equipment procurement and disposal; and facility validation testing, installation, buildup, integration, test modification, repair and removal. This effort will provide NASA with high fidelity PMMS test equipment that will be used to evaluate methods of handling hazardous substances on Space Station Freedom and to test payload accommodations.

Mechanisms Test Bed * [M-14]: This facility will be used for berthing mechanism dynamics and loads verification testing using a six degree of freedom motion simulator. The tests will be conducted for the purpose of developing components of the mechanism, such as alignment guides and capture latches, and to qualify the total berthing mechanism.

Audio/Video/Data Management System Breadboard [M-16]: This facility will be used to develop and maintain the capability to investigate and evaluate internal audio and video system components and concepts and their interfaces to the remainder of the system. This capability includes specialized test instrumentation for evaluating the performance of internal audio and video components, and includes equipment for simulating the interfaces between audio and video functions and the DMS with other interfaces. During the operational phase, the facility will be used as needed to support troubleshooting and flight system upgrades.

Electrical Systems Breadboard * [M-17]: This facility will be used to test system distribution hardware (including load converters, load center switchgear, cabling, and rack interface hardware) and automated control hardware/software (including load center controllers/MDMs and the appropriate software) for use in higher fidelity module test equipment. This breadboard will identify/characterize component to component interactions for various load and source types, define module distribution operating modes, define the control of individual integrable racks within guidelines established by the WP-04 EPS controller, and define the automated operational interfaces to other functions and controls.

Dynamics Test Facility [M-18]: This facility supports vibration, modal and acoustics testing for the development and certification of WP-01 structures.

Structural Test Facility [M-19]: The facility supports static load, pressurization and functional testing of WP-01 structures.

Repair Technology Development Facility * [M-25]: This facility will be used to test materials and processing technology for on-orbit repair. It will simulate on-orbit conditions (television chamber). It will also test and develop repair methods using: (1) reaction injection molding; (2) fiber reinforced plastic foams; (3) a space-compatible welding/cutting system; and (4) a space-compatible plasma spray system for the repair of coatings.

Guidance, Navigation and Control (GN and C) Emulator Test Bed [J-01]: The GN and C Emulator Test Bed consists of functional math models of anticipated GN and C system components programmed on separate processors, connected together in a manner to represent the GN and C architecture. This test bed provides the tools required to evaluate redundancy of GN and C components and the real-time aspects of the GN and C system operating in a distributed environment. As the GN and C system design matures, the functional processing elements will be updated to be more representative of the flight system. During the operations phase, the test bed will be used to evaluate updates necessary due to technology growth and enhanced requirements. This test bed operates in an interactive or real-time mode and is interfaced with the DMS Test Bed (J-22).

Extra-vehicular Activity (EVA) Test Bed [J-02]: The EVA Test Bed will provide the Space Station Freedom program with critical development and integrated system performance assessment. Primary goals of the EVA Test Bed include: the development of a system representative of the Space Station Freedom Extra-Vehicular Activity System; the provision of a mechanism by which advanced technology concepts are evaluated at the component and system level for EVA applications; and the provision of a facility for development, certification, acceptance, and pre-flight verification testing of the EVA hardware.

Thermal Systems Test Bed (TTB) * [J-03]: The TTB provides the Space Station Freedom program with critical elements of thermal technology development and integrated system performance assessment. Primary goals of the TTB include: the development of a ground-based system representative of the Space Station Freedom Thermal Control System (TCS) to verify the readiness of two-phase thermal technology for use on Space Station Freedom; the provision of a mechanism by which advanced technology thermal control concepts are evaluated at the system level for Space Station Freedom applications; and the provision of a facility for development and certification testing of the Space Station Freedom TCS hardware.

Large Man-rated Thermal Vacuum Chambers A and B * [J-04]: These facilities will be used to support tests which include manned EMU thermal/vacuum development and certification, integrated active thermal control system (including payload/module mechanical interfaces) thermal/vacuum development and certification, airlock certification, and numerous additional subsystems and pre-flight verification tests for other critical station mechanical systems.

Small Unmanned Thermal Vacuum Chambers * [J-05]: These facilities support the testing of component parts of the Space Station Freedom EMU active thermal control system and other thermal critical items that will be required during the development test period. Testing of thermal control subsystems with radiation heat transfer as allowed by these facilities is mandatory. A number of small vacuum chambers are available which allow unmanned vacuum testing.

Manned Vacuum Chambers (Bldg. 7) * [J-06]: The 8-ft., 11-ft., and 20-ft. Chambers and the Airlock Test Facility are used as follows: (1) the 8-ft. Chamber will be used to test a number of Portable Life Support System (PLSS) components requiring a combination of vacuum and canned man capability. Unmanned PLSS prototype verification and Unmanned PLSS certification will be supported. Acceptance of EMU's after fabrication and re-verification will be performed; (2) the 11-ft. Chamber supports manned verification of the Space Station Freedom prototype EMU. Additional flight units will require acceptance testing following fabrication, and periodic re-verification of flight EMUs is also expected; and (3) The 20-ft. Chamber will have an Airlock Test Facility and support man-rating of airlocks and airlock systems verification of airlock system procedures, crew training in EVA systems and mission testing.

Addition to Antenna and Tracking Development Lab * [J-07]: This facility will provide laboratory space and test facilities to accomplish antenna and communications equipment development, fabrication, testing and certification for numerous Space Station Freedom hands-on engineering tasks related to electro-optical tracking, communications, and robotic sensor systems.

Tracking Systems Test Bed [J-08]: The Tracking Systems Test Bed will support the development, verification and operational support of the Global Positioning System (GPS). JSC personnel will utilize the facility to evaluate candidate hardware and software approaches to GPS operations, develop receiver performance simulations, define critical design parameters and provide GPS/Shuttle flight experiment hardware. The WP-02 contractor will use the same facilities to test prototype designs and to perform final system verification testing.

Anechoic Chamber/Near Field Antenna Facility * [J-09]: This facility will test first small-scale model antennas for preliminary design values to support the antenna Preliminary Design Review (PDR); incrementally test full scale early development models and successive developmental changes; test full scale prototype and final developmental protoflight models in support of the Critical Design Reviews (CDR's) and design freeze. The facility will also test and determine the exact performance values of flight antennas for flight certification prior to delivery for Space Station Freedom installation and produce Radiation Distribution Plots (antenna patterns).

Radio Frequency Communications Lab [J-10]: This lab provides supporting development and design verification for RF communications systems such as Multiple Access Communications, EVA Communications, and Emergency S-band.

Activities include basic breadboard design, development and test; component development and test; interface tests; evaluation of design changes; e.g., alternate frequency bands, and verification testing of final hardware implementations. The lab includes microwave design capabilities as well as fabrication and test facilities. This facility provided the above type support to Shuttle antenna development and is currently supporting development of new (Block II) replacement antennas.

Electromagnetic Interference (EMI) Test Facility [J-11]: This lab will perform electromagnetic interference and susceptibility tests and evaluations on spacecraft developmental hardware and flight hardware. The lab includes unique test equipment, and trained engineering and technician personnel for conducting flight hardware EMI certification, EMI anomaly investigation, verification of shielding effectiveness, and analysis of potential electromagnetic compatibility (EMC) problem areas. This facility currently performs the above functions for the Shuttle and on-board Shuttle flight experiment packages and DOD flight-added equipment.

Electronic Systems Test Laboratory (ESTL) * [J-13]: The function of the ESTL is to take developmental C and T hardware (breadboards and prototype boxes) during their evolutionary development phases and place them operationally into the "systems level" environment in which they must successfully operate. This results in identifying major and minor system design and operational problems very early in the developmental stages when design changes are inexpensive to make. The ESTL has all the RF links for the Shuttle Program (Ground Station, TDRSS, Orbiter, EVA, payloads) generated by actual flight or protoflight equipment therein.

Flight Telecommunications Development Facility [J-14]: This facility will support the development and test of critical subsystem components for video, audio and signal processing to include definition of: (1) critical areas of system interaction; (2) needed refinements to ACD's; and (3) network end-to-end integration for space-to-space and space-to-ground development.

Communications and Tracking (C&T) Control and Monitoring System (CMS) Test Bed [J-15]: The CMS Test Bed will be used to support the design, development and evaluation of Space Station Freedom C and T systems status monitoring, and control and resource management techniques using expert systems hardware/software technology. The CMS test bed capability will use prototype flight processors, network interface units, mass storage devices, fiber optic networks and associated software in a breadboard test environment. The capability to interface the CMS test bed with other C and T subsystems breadboards and the DMS/OMS test beds will be established.

The Space Systems Automated Integration and Assembly Facility (SSAIAF) * [J-16]: This facility is a planned in-line support laboratory for the work package contractor and will be used to perform dynamic testing of docking/berthing devices, assembly sequence procedures development and fit-check verification, and automation/robotics development and evaluation. Early development activity is needed in support of the work package contractor requirements. It will provide a capability for mechanical systems integration and testing and provide a capability for real-time mission support of on-orbit assembly. Tests in this facility will be performed to develop optimum procedures for construction, inspection, maintenance and repair activities.

Electric Power Distribution and Control (EPDC) Lab/Test Bed [J-20]: This laboratory will provide a facility to support development and operational phases of

the EPDC/Data Management System interface. A minimum EPDC breadboard with work stations will be developed and interfaced with the DMS.

Avionics Engineering Laboratory * [J-23]: This facility will be used to support hardware/software flight design and integration verification testing representing the Shuttle-to-Space Station Freedom configuration. The existing facility presently supports, and is funded by, the National Space Transportation System.

White Sands Test Facility (WTSF) Propulsion Test Area [J-24A]: The WP-02 contractor has proposed to utilize the Propulsion Test Area for development, qualification, and operational support testing of the Space Station Freedom integrated propulsion element.

Thermochemical Test Area [J-25]: This test area will be used for testing of propulsion, fluids and utilities components and system breadboards to provide support for the WP-02 development effort and to flight operations.

Structures Test Lab [J-27]: This lab will support mechanical properties tests, including fatigue and crack growth properties, on materials at room temperature and high and low temperatures and structural development and verification tests on Space Station Freedom components and structural assemblies.

Dynamic Structural Testing [J-28]: The Vibration and Acoustics Test Facility and the Dynamic Docking Test Facility will support hardware development and verification; perform model, vibration and acoustic testing to verify math models and structural integrity for launch conditions; verify math models and evaluate structural borne vibrations and acoustics for on-orbit conditions; and perform docking tests to support the development and verification of docking/berthing mechanisms.

Graphics Analysis Facility [J-36]: The Graphics Analysis Facility performs systems engineering analyses of man-machine interfaces, flight operations, vehicle and payload design, and mission planning via customized, interactive, 3-D computer graphics packages (PLAID/TEMPUS). The unique man-modeling software, which augments the analysis capabilities, is continually being enhanced with new technologies and an expanding anthropometric data base. The facility also supports the Space Station Freedom Flight Telerobotics Servicer program.

Food Systems Engineering Facility [J-37]: This facility will be used for food system component testing and evaluation, the development of a crew training program for food system operations and food provisioning, consisting of the flight food, its packaging and all accessory items for preparing and serving it. During the operational phase, this facility will provide sustaining engineering and technology enhancements to the food systems and provide crew member orientation and training in food system procedures and operations.

Instrument Thermal Test Bed (ITTB) [G-04]: The Instrument Thermal Test Bed is a full scale test facility that will permit the ground testing, qualifying and certifying of new, two-phase thermal technology for Space Station Freedom applications. The ITTB can provide a realistic simulation of the attached payload and/or platform thermal environment. A variety of cold plates, condensers, heat exchangers, and similar equipment can be accommodated. The ITTB can operate in either a pure capillary, mechanically-pumped or hybrid mode. The thermal capacity is over 12 kilowatts and the transport length can be either 10, 20 or 30 meters. In

addition to accommodating a wide variety of equipment, the ITTB is designed to be very flexible and permit hybrid reconfigurations.

Spacecraft Systems Development and Integration Facility/Integration, Test and Verification Facility - Attached Payload Accommodations Equipment (SSDIF/ITVF - APAE) * [G-07]: This facility, located in the Spacecraft Systems Development and Integration Facility (SSDIF), will support Integration, Test and Verification for WP-03 Attached Payload Accommodations equipment and user needs. Services will be provided for integrating, testing and verifying the interfaces, training and operation of payloads with the APAE. It will be used to define interfaces during the breadboard stages and then transition into an operational system to support anomaly isolation/correction, the development of operation procedures, training and the evaluation of enhancements.

Spacecraft Systems Development and Integration Facility/Integration, Test and Verification Facility - Platforms (SSDIF/ITVF - Platforms) * [G-08]: This facility, located in the SSDIF, is required to support Integration, Test and Verification for WP-03 platform elements and user needs. An integration facility with platform capabilities will integrate platform subsystems and payloads into the Space Station Freedom network for future missions. The ITVF will also have the capability to verify platform interfaces, support anomaly isolation/correction, the development of operation procedures, training and the evaluation of enhancements.

Development, Test and Evaluation Facility [G-12]: This facility will support the development of the test and evaluation of the demonstration test flight equipment and the Flight Telerobotic Servicer flight elements. Further, it will be used to develop associated procedures, techniques and scenarios, in addition to supporting training, end-to-end tests, anomaly investigations and enhancement development. The test facilities include Thermal Vacuum, RFI/EMI, Vibration and Static Loads.

Environmental Chamber B-2, Plum Brook [Le-01]: The Environmental Chamber will be used to support WP-04 contractor tests of the Solar Dynamic Receiver and Power Conversion Unit under thermal/vacuum conditions. It will not be required if Le-02 (Tank 6) is available to the program.

Environmental Chambers - Tanks 5 and 6 [Le-02]: Tank 5 will be used to conduct supporting development tests and support WP-04 contractor tests of photovoltaic solar array panels. These tests will evaluate the interaction of plasma with the array panels. Tank 6, after modifications, will be used to conduct supporting development tests of an advanced development solar dynamic receiver and to support WP-04 contractor tests of the Solar Dynamic Receiver and Power Conversion Unit. These tests will evaluate the performance of the systems under thermal/vacuum conditions.

Power Management and Distribution (PMAD) System Test Bed [Le-03]: The purpose of the PMAD System Test Bed is to conduct supporting development tests that include the testing, control, and operation of a single channel of an integrated PMAD System Test Bed. Specific tasks include: the demonstration and test of the source conversion and load conversion hardware; verification of the proper operation of the power management processor, power source controller, power distribution controller and main bus switching controller with the Power Distribution and Control Unit (PDCU) and Main Bus Switching Unit (MBSU); and the verification

and demonstration of the ring bus protection system for hard and soft faults including the classification of faults and reconfiguration of loads.

Space Power 20 KHz Test Bed Facility [Le-04]: The Space Power 20 KHz Test Bed Facility is used to conduct supporting development tests of a 20 KHz breadboard system. This includes source inverters, load converters, distribution system components and cabling, and computer controls.

Power Systems Facility (PSF) * [Le-05]: The PSF will be used to support experimental evaluations in a test bed of alternating current distribution systems and system control concepts and architectures for the Space Station Freedom Electrical Power System. This will include PMAD and energy storage system supporting development tests and the support of WP-04 contractor tests of the PMAD system. Also included is optical evaluation testing of the Advanced Development Solar Concentrator. The PMAD test bed will consist of solar arrays and/or solar array simulators, representative loads, candidate storage systems, power management and distribution, protection, and control systems. The test bed will be supported by subsystem and component test laboratories.

Nickel-Hydrogen (NiH_2) Cell Test Bed [Le-06]: The nickel-hydrogen cell test bed is used to conduct supporting development tests of NiH_2 cells. These will provide lifecycle data on NiH_2 cells prior to CDR and input to cell component evaluation and selection prior to First Element Launch.

Space Power Facility, Plum Brook * [Le-08]: This facility will be used to test large Space Station Freedom structures, including antennas and solar-powered panels to validate future growth configurations and to verify the control of flexible structures design and develop methods for automation/assembly. The existing Space Power Facility will be used to support the experimental evaluation of electrical power system integrated assemblies for Space Station Freedom. This will include WP-04 contractor tests of the photovoltaic module.

Rotary Joint Fluid Transfer Test Bed [La-05]: This facility will be used to perform development tests using anhydrous ammonia on candidate fluid coupler design and to qualify fluid couplers for fluid proof loads and life.

Structures Laboratory [La-06]: The structures laboratory is used to develop a broad range of structural concepts, including erectable Space Station Freedom trusses, deployable mechanisms, mobile remote manipulator systems, and automated structural assembly techniques. The Space Station Freedom hardware developed in this facility is applicable to the Phase I, Phase II, and evolutionary concepts.

Neutral Buoyancy Test Facility (NBTF) * [A-01]: The NBTF employs an 11 ft. diameter, 9 ft. deep tank to evaluate new space suit and end-effector technology. Under future-year funding, it will be relocated to the Human Performance Research Laboratory and enlarged to permit the early evaluation of technologies critical to the timely evolution of equipment and procedures for future zero-g extra- and intra-vehicular activities. The relocated NBTF will support full-range-of-movement video recording and motion analysis.

3. MOCK-UPS/SIMULATORS/TRAINERS

Payload Operations Training Facility (POTF) [M-08]: The POTF will provide for the development, maintenance and verification of payload operations training, including hardware and software that will support the training of payload crew, POIC personnel, experimenters and users. This facility will provide both Space Station Freedom data as well as training.

One-g Mock-up * [M-09]: This facility will be used for the design, development and evaluation of distribution systems routing and utility access, direct-mounted equipment locations and human factors assessments.

Neutral Buoyancy Simulator Facility [M-10]: This facility will be used to assess zero-g design impacts upon WP-01 elements. Development testing of Space Station Freedom assembly operations is planned, along with repair techniques, element interfaces, and Orbital Replacement Unit (ORU) servicing requirements.

Communications Systems Simulation Laboratory (CSSL) [J-12]: The CSSL is the primary facility for the simulation and analysis of Space Station Freedom communications links with the TDRSS, Shuttle, EVA's, OMV, MSCS, free-flyers, etc. Use of the CSSL includes system design, design verification/optimization, derivation of system specifications, flight-hardware performance predictions, anomaly investigations and mission-dependent operational performance predictions. The CSSL contains the computer-aided analysis tools which will be used to provide end-products for three C and T in-line tasks: (1) compatibility analysis; (2) circuit margin analysis; and (3) RF coverage analysis.

Systems Engineering Simulator (SES) Station/On-orbit Simulator * [J-18]: The SES will be used by the WP-02 contractor and is required to provide a real-time man-in-the-loop simulator supporting Space Station Freedom. The simulator will provide the base for the evaluation of development and operational issues concerning proximity operations with the Shuttle, MMU modules, OMV, OTV, and other free flyers with Mobile Service Center operations. The simulator includes a computer complex, Orbiter and MMU crew stations, all complete with visual displays shared with Shuttle simulators and functional representations of workstations.

Neutral Buoyancy Laboratory (NBL) * [J-38]: The NBL will be a large neutral buoyancy simulation facility that will provide the mandatory capability to support EVA activities associated with the large-scale on-orbit construction, verification, crew training, and mission operations. Products are Engineering Evaluations, Procedures Verifications, EVA Training and Real-Time Mission Support.

Space Station Mock-up and Trainer Facility (SSMTF) * [J-39]: The purpose of the SSMTF is to provide one-g mock-ups and trainers, a mobile remote manipulator system and other associated facilities in support of the Space Station Freedom program. The function of this facility is to support engineering development and integration of hardware and systems; support training for flight crews, flight controllers and instructors; support real-time flight operations; and support NASA Public Affairs Office activities. Included in this facility are the following: the Man-tended/Permanent Manned Presence (MT/PMP) mock-up which is composed of the Habitation, JEM, ESA and four node modules; the Mobile Remote Manipulator Development Facility (MRMDF); and part-task mock-ups and trainers as required. The SSMTF, along with the NBL and WETF, comprise the Manned Systems Integration Test Bed.

Weightless Environment Training Facility (WETF) [J-40]: The WETF provides neutral buoyancy simulator support for engineering evaluations, EVA flight procedure development and validation and crew training, pending the availability of the NBL facility at JSC. An operational STS Remote Manipulator System (RMS) is installed in the WETF. The WETF neutral buoyancy simulators are an integrated element within the JSC task of flight procedure development, crew training and evaluation of astronaut interface hardware designs.

Space Station Training Facility (SSTF) * [J-41]: This planned facility supports ground training applications software development; manned base training for crew and ground support personnel; integrated operations training for systems and payloads; flight and ground procedures verification; flight software verification; and SSIS network simulation.

Spacecraft Systems Development and Integration Facility/Integration Test and Verification Facility - Robotics Assembly and Servicing Simulation Facility (SSDIF/ITVF - RASSF) * [G-05]: This Robotics Assembly and Servicing Simulation Facility (RASSF), located in the SSDIF, provides support for the WP-03 Flight Telerobotics Servicer and servicing simulation elements and user needs. It provides a ground system that uses FTS, attached payload and supporting element models for the evaluation and development of Phase I Assembly and Servicing. Further, the facility will be used to support anomaly isolation/correction, the development of verification of operations procedures, the evaluation of enhancements, and training.

Payload Accommodations Assessment Facility [La-03]: This facility will be used to analytically provide timely and rapid evaluation of the ability of Space Station Freedom to accommodate payloads, the impact that the operation of individual or sets of payloads would have on Space Station Freedom or other payload operations, and the impact that off-nominal operations would have on payload operations.

4. HEALTH/SAFETY/CREW PRODUCTIVITY

Medical Operations and Research Building. * [J-29]: This facility will house the medical operations and research laboratory space needed for the accomplishment of biomedical operational and research medicine programs required for the support of Space Station Freedom crew certification, flight preparation, health maintenance and monitoring, and baseline collection and analysis. It is required to support Extended Duration Crew Operations (EDCO) and the Health Maintenance Facility (HMF).

Human Computer Interaction Laboratory [J-32]: The Human Computer Interaction Laboratory defines requirements for optimized interactions between humans and computers, including display content and format, control type, use of text and graphics, and workstation design. The Laboratory uses state-of-the-art components and performs evaluations of conceptual designs, conducts research on these topics and applies research results to on-going programs.

Lighting Laboratory [J-33]: The Lighting Laboratory performs analyses of factors relevant to the astronauts' visual environment. Special equipment is employed to assess ambient and special lighting needs, reflective and transmissive characteristics of materials, payload/vehicle reflectors and running lights, and

IVA/EVA operations lights. The Laboratory defines requirements and evaluates design concepts for lights, alignment aids, docking targets, etc., for on-going programs. The Laboratory also performs research to take advantage of new technologies applicable to the visual environment.

Anthropometric Biomechanics Lab [J-34]: The Anthropometrics and Biomechanics Laboratory will quantify human performance capabilities under shirt-sleeved and space-suited conditions. The Laboratory measures strength and motion in one-g and simulated zero-g conditions (via neutral buoyancy and Keplerian flight) and is preparing for measurement in true zero-g spaceflight. The Laboratory also measures static and dynamic anthropometry to complement developing the capability for laser-mapping the body. The impact of human performance on vehicle design is identified in special tests, which are coordinated with design personnel. The laboratory research results are disseminated to design personnel and are input to the computer man-modeling efforts conducted by the Graphics Analysis Facility.

Human-Interactive Systems Test Bed (HIST) [A-03]: The Human-Interactive Systems Test Bed (HIST) will be used to develop and validate technologies for optimum human interaction with complicated automated systems. The HIST will also be used to develop guidelines for evaluating crew productivity and for optimizing overall system reliability, including the human element. Located in the highbay area of the Human Performance Research Laboratory, the HIST will include mock-ups of Space Station Freedom pressurized modules and of ground facilities such as the Principal Investigator and Ground Control stations. It will include a computational system modeled after the Space Station Freedom Software Support Environment and consisting of workstations, VAX-class processors, as well as other Data Management System and Operations Management System hardware and software characterizing the Block I and II SSIS environments.

5. AUTOMATION AND ROBOTICS TECHNOLOGY

Robotics Facility (Flat Floor) * [M-15]: This facility will support testing and evaluation of Space Station Freedom modules which will include test equipment, manipulators, and end effectors needed to evaluate flight hardware.

Advanced Systems Development Laboratory (ASDL) * [J-17]: The Advanced Systems Development Laboratory (ASDL) will provide analytical and test bed support for the development of Displays and Controls Workstations and manipulator systems. Integration of these systems and integration with the DMS Test Bed will also be provided. Eventually, expert systems applications will be integrated and evaluated. The capability is provided to evaluate the Multi-purpose Applications Console which supports subsequent utilization in the Systems Engineering Simulator proposed by the WP-02 contractor.

Man-systems Telerobotics Lab [J-35]: The Man-systems Telerobotics Laboratory will perform research concerning the human interfaces with manipulator/telerobotic/robotic systems across a wide spectrum of system capabilities (i.e., manual control to supervisory control). The Laboratory supports development of the Flight Telerobotics Servicer program and provides man-machine requirements, conceptual design inputs, and design evaluations for telerobotics workstations, robot design and robot sensor systems (e.g., vision, proximity, force).

Development, Integration and Test Facility (DITFAC) * [G-11]: This facility will allow the performance of engineering analyses and simulations; the testing and

verification of telerobotic components; the development and testing of operational scenarios and support the integration and demonstration of flight test systems.

Spacecraft Systems Development and Integration Facility/Integration, Test and Verification Facility - Flight Telerobotic Servicer (SSDIF/ITVF-FTS) [G-13]: The Flight Telerobotic Servicer will utilize the ITVF area in the SSDIF for assembly, integration and servicing task verification, and test with a focus on robotic interfaces with specific payloads. After the launch of the FTS, the facility will continue to test and integrate new robotic technology upgrades and provide verification of the FTS/payload servicing capability and associated interfaces.

Robotics Laboratory [La-07]: The Robotics Laboratory is used to conduct research on the applicability and capability of a variety of manipulator and robotic systems and concepts. The lab is used in the development of automated structural assembly concepts, the evaluation of various manipulator arms and support the Flight Telerobotic Servicer program.

Controls and Robotics Laboratory * [JPL-01]: The Controls and Robotics Laboratory will support various JPL programs on Controls, Sensors, Actuators, Robotics, Teleoperators, Human Factors and Artificial Intelligence. Laboratory space and workstations with computer terminals are operationally coupled to permit large, complex, proof-of-concept demonstrations and integrated experiments and tests. The required technology for Space Station Freedom missions will drive the research and development products of this laboratory.

Automation Sciences Research Facility * [A-02]: The Automation Sciences Research Facility will house the basic research and development activities associated with intelligent autonomous systems technology. The facility will include space for mini-test beds, which will be used to develop and validate automation technologies applicable to Space Station Freedom without impacting the schedules of the major test beds. It will share the use of the Human-Interactive Systems Test Bed (A-03) in the Human Performance Research Laboratory in order to enhance the effectiveness of systems that involve significant man-machine interfaces. The technology developed will increase safety and productivity and reduce costs for many programs -- including a permanent manned presence in space, scientific missions and future Lunar/Mars unmanned and human expeditions.

6. MATERIALS TECHNOLOGY

Materials Compatibility Lab [M-04]: This facility will support materials compatibility analysis and testing in support of the PMMS Waste Management System. Long duration tests of material, component, and system degradation will be conducted using a wide variety of chemical substances so that synergistic effects can be evaluated. Ultimately, a fully configured PMMS Waste Processing Facility will be established to test the effectiveness of the system and validate replacement procedures to identify materials which must be prohibited. This effort will result in a laboratory testing facility primarily for the handling of toxic and corrosive materials needed to develop and qualify materials/components (valves, accumulators, regulators, etc.) for the PMMS system.

Combined Environmental Effects Facility * [M-20]: This facility will be used by the WP-01 contractor to provide a data base for screening, selecting, and qualifying materials for long-term space exposure by performing simulation tests of the effects

of combined environmental influences (thermal, ultraviolet, electron, proton) and analyses of the data acquired.

Contamination Evaluation and Materials Quality Facility [M-21]: Materials and systems will be selected and tested in this facility under realistic operating conditions (temperature and pressure) to verify that contamination levels are acceptable. Products include: (1) derivation of detailed WP-01 engineering requirements based on program needs; (2) definition of cost-effective control methodology; (3) development of thermal/vacuum out-gassing/deposition/effects data base; (4) qualification of materials for WP-01 hardware and systems based on anticipated operating temperatures; (5) improved VCM material selection testing capability; and (6) improved determination of process parameters for outgas contamination conditioning of materials.

Lubricants Evaluation Facility [M-22]: This Lubricants Evaluation Facility is needed to perform in-house lubrication tests, materials evaluations and characterization of lubricants and materials in support of Space Station Freedom research, development, and operations.

Materials Combustion Deterioration Test Facility [M-23]: This facility will be used to conduct tests as specified in NHB 8060.1B for Space Station Freedom work package contractors to obtain information on the flammability and chemical compatibility of materials. The tests conducted are to determine the effect of the Space Station Freedom environment on materials usage applications from a safety standpoint and the long term effects of the environment on the flammability of materials. Materials will also be tested in high pressure oxygen and in storable propellants.

Composites Technology Development Facility * [M-24]: This facility will support composite materials development for structural applications, including racks, pressure vessels, longerons, fasteners, and the Log Module plug door. Test articles will be fabricated. Non-destructive evaluation procedures will be defined for cured-part testing and repair verification. Composite materials applications (thermoset and thermoplastic systems) will be evaluated for primary structure applications.

Atomic Oxygen Test Facility [M-26]: This facility will be used to select materials to meet the atomic oxygen (AO) resistance requirement, candidate WP-01 hardware materials and evaluate protective coatings. Also, an AO data base is needed to aid designers in the selection of acceptable materials for the scope of hardware applications anticipated. The WP-01 contractor plans to utilize this facility to obtain the required AO test data. The facility will support testing of long term AO effects on Space Station Freedom materials and the continued evaluation of new materials that are to be placed in orbit

Meteoroid/Debris Protection Test Facility [M-27]: The Meteoroid/Debris Protection Test Facility will be used by the WP-01 contractor and is required for screening, evaluating, selecting and qualifying candidate materials, structural configurations, penetration effects of module shell and internal systems for long term debris protection. Other contractors have also requested usage of the facility for structural and pressure vessel testing.

Non-destructive Evaluation (NDE) Facility [M-28]: This facility supports the performance of nondestructive evaluation of fracture-critical WP-01 development,

qualification, and flight hardware. Diagnostic hardware, specifications, procedures, etc., are currently in place. The WP-01 contractor intends to utilize the facility during the development phase. The facility will be used during the operations phase to continue NDE analysis of experiment/equipment racks and other equipment that is returned from orbit.

White Sands Test Facility (WSTF) Materials Laboratory [J-24B]: The WP-02 contractor has proposed to utilize the WSTF Materials Laboratory for Space Station Freedom materials, components and hypervelocity impact testing. Materials tests include flammability, odor evaluations, off-gassing, high pressure impact, ignition susceptibility of metals, combustion properties, explosive characterization of aerospace fluids, etc. Components testing encompasses off-gassing/out-gassing tests of flight hardware, the service life of valves, reliability and qualification testing of components, etc. Tests are also proposed to assess potential hazards caused by the impact of space debris/meteoroids on vessels pressurized with space fluids such as oxygen, nitrogen, hydrazine, and ammonia.

Materials Technology Labs [J-26]: These materials technology labs are used to conduct studies in the areas of materials development, evaluation and certification for long-life. These studies are required to provide data to the work package contractor.

Hypervelocity Test Facility [J-31]: This facility provides the ability to screen and evaluate new materials and configurations. The objective is to evaluate and develop new light-weight materials for use as spacecraft and EVA space-suit shielding. Provides the capability for in-house testing of the effects of small debris particles on Space Station Freedom components such as space-suits, windows and various structural members.

Materials Testing Laboratory [La-04]: This facility will be used to qualify Space Station Freedom thermal control coatings for long-term stability under low-earth orbit conditions and perform verification thermal-cycling tests of composite truss tubes to determine the microcrack resistance of the selected graphite epoxy truss tube material.

7. GROUND AND SPACE OPERATIONS

Systems Engineering and Development Facility * [M-05]: This facility will provide an office building which will be used to house the Space Station Freedom Projects Office and associated personnel. The building will be attached to a building which currently houses the majority of the Space Station Freedom test and training equipment.

Payload Operations Integration Center (POIC) [M-06]: This facility will be used to support real-time payload operations. It will provide an interface with the SSCC and user facilities. It provides a central control point for payload operations; integrates science operation centers; and includes host computer systems for mission planning systems and analytical tools.

Engineering Support Center (ESC) [M-07]: The ESC facility will be used as an adjunct to the Huntsville Operations Support Center (HOSC), to provide WP-01 engineering support for real-time operations. It also serves as a control point for requests from SSCC and POIC for engineering support for operations and supports engineering flight evaluation and anomaly resolution.

Space Station Control Center (SSCC) * [J-42]: The SSCC will provide for continuous real-time Space Station Freedom control and support, manned base systems integration/support, flight activities integration/support, flight crew and ground support personnel integrated training, operations planning and preparation support, ground applications software development and operations concept and procedures verification. ESC functions are inherent in the SSCC.

Platform Control Center (PCC) * [G-01]: This facility, located in the Customer Data Operations Facility (CDOF), will provide for control of the Platform core systems as follows. originate, validate, and verify commands for the core systems; provide a real-time command capability; monitor Platform core systems; track health and safety information on the Platform systems; and manage the Platform hardware and software configurations.

Engineering Support Center - Attached Payload Accommodations Equipment (APAE) * [G-02]: This facility, located in the CDOF, will provide real-time monitoring of maintenance and sustaining engineering for APAE. It will also provide an APAE simulator for training, trend analysis for performance evaluations, operations readiness demonstrations and real-time support for the SSCC and POIC, as required.

Engineering Support Center - Platforms * [G-03]: This facility, located in the CDOF, will allow the following major functions of the Space Station Freedom Platform to be performed: configuration control; performance evaluation; procedures development and evaluation; support for test, verification, and training; and real-time support to the Platform Control Center.

Integrated Logistics Support System [G-06]: This system, located in the SSDIF, will provide storage and staging for WP-03 ground systems at GSFC, including staging for ITVF, GSE, FSE, and short-term storage for flight ORU's. It will also allow logistics planning and support for maintenance and operations, sustaining engineering and systems development for Space Station Freedom program activities.

Flight Dynamics Facility [G-10]: This facility will provide orbit, attitude and maneuver support for Platforms, APAE Pointing Systems, and Servicing. It will also provide Flight Dynamics Mission planning and operations for platforms and their payloads including the validation of navigational systems, transmittal of space network support data and the calibration of attitude sensors.

Engineering Support Center - Robotics * [G-14]: This facility, located in the CDOF, will provide in-flight performance evaluation of the FTS to support integration test verification, training, and real-time support to SSCC, POIC and PCC. It will also provide configuration control, procedures development and evaluation and support integration, test and verification.

Engineering Support Center * [Le-09]: This facility will be used to support flight operations of the electric power system and provide engineering flight data evaluation, trend analysis and anomaly resolution. It also serves as a control point for power systems sustaining engineering support.

Polar Platform Processing Facility * [K-01A]: This facility at VLS provides the capability to receive and process the Space Station Freedom Polar Platform during

non-hazardous operations. The facility can be used for carrier and propulsion module pre-launch checkout and a dry-mate of the carrier and propulsion module.

Polar Platform Hazardous Processing Facility * [K-01B]: This facility at VLS provides the capability to receive and process the Space Station Freedom Polar Platform for hazardous processing. It can also be used for propulsion module loading and wet mate/de-mate of the carrier and propulsion module.

Space Station Hazardous Processing Facility * [K-03]: This facility will be used for servicing Space Station Freedom propulsion components. Gaseous oxygen and hydrogen will be loaded in tank farms on the early missions.

Space Station Logistics Facility * [K-04]: This facility will be used to consolidate and integrate Space Station Freedom logistics activity: intermediate and depot level maintenance, training, supply support, storage, carrier/rack buildup; and shipping and receiving.

Modifications for Space Station Logistics * [K-05]: These facilities provide air-conditioned logistics space for orbital replacement units. It will supplement logistics storage capacity in both [K-04] and [K-06] and will have specific areas identified for GSE storage, reusable container storage and new container storage.

Space Station Processing Facility (SSPF) * [K-06]: This facility will be used for the integration, de-integration, and checkout of all non-hazardous Space Station Freedom elements. It will include final assembly, servicing, testing of elements, logistics element loading/unloading, and payload operations.

Space Station Technology Discipline Operations Center (DOC) * [La-01]: The Space Station Technology Discipline Operations Center will provide a facility from which principal investigators can perform payload operations individually or integrated with other technologists involved with similar or related experiments. The facility will provide the equipment necessary for real-time command, control, and communication with experiment payloads both on-orbit and pre-launch, and for data capture, processing, and storage. This project provides for the modification to Building 1244 which will include the addition of approximately 20,450 square feet, which includes space for mission control rooms, computer room, data operations control room, data storage, conference rooms and offices.

III. SPACE STATION FREEDOM ROLES AND RESPONSIBILITIES vs FACILITIES

The FRP concluded that facilities/activities should be viewed in the context of the roles and responsibilities as recommended in the "Space Station Operations Task Force-Summary Report" and defined in the "Work Package Directive" of February 13, 1987. In instances where the roles and responsibilities were not well-defined by this document (i.e., ARC, JPL and LARC), the FRP relied on input from the respective Level III participants in the context of the historical roles played by these organizations. These roles were then considered for applicability to the Space Station Freedom program and included in the facilities review, as appropriate. The chart shown in Figure 3 (fold-out) presents the roles and responsibilities and is designed to highlight the association between the facilities and the roles assigned to each Center. The reader is encouraged to review Section II when using this chart.

The presence of a dot is an indication that a facility is proposed to support the stated role, support another Center or its work package contractor, or support advanced development efforts that are funded through Level I. To illustrate this concept, scan horizontally across the row entitled "Thermal Systems Test Bed" (J-03). Note the location of each dot. J-03 will support not only JSC, but GSFC and ARC as well; including the JSC and GSFC work package contractors. In addition, this particular facility will support the development of automation technology under the auspices of Level I. But caution should be exercised when interpreting the chart. Continuing with the above illustration, the dots indicate a need for GSFC and ARC to utilize J-03, but do not necessarily imply the existence of a formal agreement authorizing its use.

Readily apparent when viewing this chart is the heavy cluster of dots within the boundaries of the roles and facilities for a particular Center. This is not unexpected, given the fact that the chart is based on roles and responsibilities, and is not intended to show all activities that have a significant relationship with a facility. This explains the relative absence of dots outside the boundaries mentioned above. The next section of the report concerns a chart that addresses significant relationships; a chart that is designed to highlight functions, hardware and systems.

IV. SPACE STATION FREEDOM FUNCTIONS vs FACILITIES

Another way of viewing the facilities/activities is to focus on the separate facilities which, acting together, provide the capability to produce an element, develop a subsystem or perform ground-based operations. This is the premise behind the chart shown in Figure 4 (fold-out). It requires the identification of all activities that have a significant relationship with a facility, regardless of where the role and responsibility lies. Activities as used here refer to the column headings shown on the chart. They have been rearranged from the previous chart to emphasize the ground-based operations functions and hardware/systems development. In general, the same principles of interpretation apply. The reader is encouraged to review Section II when using either of the fold-out charts presented in Figures 3 and 4.

Besides the dot which indicates a need, three additional symbols are employed here: M, S and T. "M" designates a mock-up, "S" specifies a simulator, and "T" refers to a test bed. Mock-ups and simulators were discussed in Section II. A test bed is a facility for integrating and testing prototype technology hardware and/or software at the system or component level. It may utilize one or more simulators and even contain a specially-designed mock-up. Referring to Figure 4 (fold-out), a typical example would be the Core Module Integration Facility (M-02). The T's shown on this row mean that M-02 serves as a test bed for ECLSS and internal TCS development; the dots indicate that M-02 supports development of airlock, internal audio/video, and manned systems components; and the M's identify mock-ups that are a part of the test bed assembly. By scanning vertically down a column that has a symbol on the M-02 row, other facilities can be identified that combine with M-02 to produce the hardware or system.

Note that the symbols are more dispersed, with less convergence about any particular group of activities. Although the dispersion is influenced by the design of the chart, the inference is that facility support crosses all boundaries of function, hardware and system. Upon close examination of the MSFC facilities, the symbols in the hardware columns are more prevalent; but, when compared with the dots in Figure 3 (fold-out), the convergence of symbols in Figure 4 (fold-out) is less apparent. The point is, that, while the chart demonstrates that most MSFC facilities are associated with hardware and systems development, few facilities support ground-based operations. A similar examination will show that JSC facilities do not seem to favor one set of activities over another. On the other hand, it is interesting to note that no GSFC facilities are required to support systems development activities. These results are not surprising and, in fact, reflect the responsibilities that have been assigned to the various Centers.

PRECEDING PAGE BLANK NOT FILMED

PAGE 24 INTENTIONALLY BLANK

SPACE STATION FREEDOM ROLES & RESPONSIBILITIES versus FACILITIES

CENTER	FACILITIES	CODE	MSFC: Payload Planning/Ops.	MSFC: Payload Crew Training	MSFC: Internal TCS	MSFC: Internal Audio/Video	MSFC: Hab Module	MSFC: Logistics Elements	MSFC: Lab Module	MSFC: Node & Airlock Sys. Comp.	MSFC: Manned Sys. Components	MSFC: ECLSS	JSC: Airlocks	JSC: Berthing/Docking	JSC: Resource Nodes	JSC: Integrated Truss Assy.	JSC: Propulsion System	JSC: Mobile Transporter	JSC: C & T	JSC: DMS	JSC: EVA Systems	JSC: GN & C	JSC: Thermal Control	JSC: Assembly & Ext. Sys. Mnt.	JSC: Manned Systems	JSC: Crew Training	JSC: Mission Planning/Ops.	JSC: Flight Crew Health Ops.	GSFC: Attch Payload Accom & Equip	GSFC: Customer Serv. & Assy.	GSFC: Flt. Telerobotic Servicer	GSFC: Platforms	GSFC: Platform Planning/Ops.	LERC: PV Module	LERC: PMAD	LERC: Solar Dynamics	KSC: Logistics Support	KSC: Prelaunch/Postlanding Ops.	LARC: Technology Payloads Evolutionary Definition (Scarring)	JPL: Telerobotics R&T	ARC: Centrifuge	ARC: Automation R & T	ARC: Human Factors R & T	CONTRACTOR REQUIRED: WP-01	CONTRACTOR REQUIRED: WP-02	CONTRACTOR REQUIRED: WP-03	CONTRACTOR REQUIRED: WP-04	LEVEL I ADV. DEV.: Automation	LEVEL I ADV. DEV.: Robotics
MSFC	WP-01 Manufacturing & Assembly Bldg.	M-01	●		●	●	●	●	●	●[3]	●[3]	●																																			
	Core Module Integration Facility	M-02			●	●	●	●	●	●	●	●																																		
	Process Materials Management System	M-03							●			●																																		
	Materials Compatibility Lab	M-04							●																																					
	Systems Engineering & Dev. Facility	M-05	●	●	●	●	●	●	●	●	●	●																																		
	Payload Operations Integration Center	M-06	1 3 ●																																											
	Engineering Support Center	M-07			●	●	●	●	●	●	●	●																																		
	Payload Operations Training Facility	M-08		●[1]																																									
	One-g Mock-up	M-09					●	●	●	●	●																													●[7]						
	Neutral Buoyancy Simulator Facility	M-10					●	●	●	●																					●[5]		●[5]				●[6]							●	●		
	Mechanisms Test Bed	M-14					●		●	●																																				
	Robotics Facility (Flat Floor)	M-15					●		●	●																						●[5]	●[5]												●		●
	Audio/Video/DMS Breadboard	M-16				●																																								
	Electrical Systems Breadboard	M-17			●	●	●[4]	●[4]	●[4]		●	●																														●[7]	●[7]					
	Dynamics Test Facility	M-18					●	●	●	●																							●[5]											●			
	Structural Test Facility	M-19					●	●	●	●																																				
	Combined Environmental Effects Facility	M-20					●	●	●	●																																				
	Contamination Eval. & Mat. Quality Fac.	M-21					●	●	●	●																																				
	Lubricants Evaluation Facility	M-22					●	●	●	●																																				
	Materials Combustion Deterior. Test Fac.	M-23					●	●	●	●																																				
	Composites Technology Dev. Facility	M-24					●	●	●	●																																				
	Repair Technology Dev. Facility	M-25					●	●	●	●																																				
	Atomic Oxygen Test Facility	M-26					●	●	●	●																																				
	Meteoroid/Debris Protection Test Facility	M-27					●	●	●	●			●[9]		●[9]	●[9]																						●[6]						●	●		●		
	Non-destructive Eval. (NDE) Facility	M-28					●	●	●	●																																				
JSC	GN & C Emulator Test Bed	J-01														●	●					●						●																		
	EVA Test Bed	J-02											●									●[10]		●	●	●	●				●[5]														
	Thermal Systems Test Bed	J-03													●	●							●[11]		●	●	●						●[5]								●[7]					●		●
	Large Man-rated Thermal Vac. Ch. A & B	J-04											●	●		●		●				●	●	●	●	●	●														●[7]						
	Small Unmanned Thermal Vac. Ch.	J-05																				●	●			●																				
	Manned Vacuum Chambers (Bldg. 7)	J-06											●[8]	●								●				●	●														●[7]			●	●		
	Addition Antenna & Tracking Dev. Lab	J-07												●				●				●	●					●																		
	Tracking Systems Test Bed	J-08												●				●				●	●																							
	Anechoic Ch./Near Field Antenna Fac.	J-09												●				●				●	●					●																		
	Radio Frequency Communications Lab	J-10																●				●																								
	Electromagnetic Interference Test Fac.	J-11																●				●																								
	Communications Systems Sim. Lab	J-12																●				●																								
	Electronic Systems Test Laboratory	J-13												●				●							●			●																		
	Flight Telecommunications Dev. Facility	J-14																●																												
	C&T Control & Monitoring Sys. Test Bed	J-15											●		●			●				●	●								●[5]													●		
	Space Systems Auto Integ & Assem Fac.	J-16												●		●	●						●			●		●																		
	Advanced Systems Development Lab	J-17														●	●	●				●												●[5]											●		●
	SES Station On-orbit Simulator	J-18												●		●		●				●	●			●	●	●						●[5]											●		●
	Engineering Computation Fac.-C830&840	J-19														●							●																							
	Elect. Pwr. Dist. & Control Lab/Test Bed	J-20																					●[4]																							
	AC&S Test Bed	J-21												●		●	●						●																							
	Data Management System Test Bed	J-22																					●[12]	●	●						●[5]		●[5]								●[7]			●	●		●
	Avionics Engineering Lab	J-23																					●																							●	
	WSTF Propulsion Test Area	J-24A															●																													
	WSTF Materials Laboratory	J-24B														●																													
	Thermochemical Test Area	J-25															●																												
	Materials Technology Labs	J-26											●	●	●	●	●	●	●	●			●																							
	Structures Test Lab	J-27											●	●		●		●																												
	Dynamic Structural Testing	J-28											●	●	●	●		●																												
	Medical Operations & Research Bldg	J-29																										●	●																	
	Hypervelocity Test Facility	J-31											●		●	●	●						●		●																				
	Human Computer Interaction Lab	J-32																					●	●				●	●														●		●
	Lighting Lab	J-33											●		●								●					●	●																
	Anthropometric Biomechanics Lab	J-34																					●					●																
	Man-systems Telerobotics Lab	J-35															●						●	●	●	●																		
	Graphics Analysis Facility	J-36											●	●	●	●		●					●										●[5]	●[5]											
	Food Systems Engineering Facility	J-37																										●	●																
	Neutral Buoyancy Lab	J-38											●	●	●	●		●					●					●[16]	●				●[5]	●[5]	●[5]	●[5]		●[6]				●[7]			●	●		
	Space Station Mock-up & Trainer Facility	J-39											●	●	●	●		●				●	●					●[16]	●	●			●[5]		●[5]	●[5]								●	●		
	Weightless Environment Training Facility	J-40											●	●	●							●						●[16]	●	●			●[5]	●[5]	●[5]	●[5]		●[6]				●[7]			●	●		
	Space Station Training Facility	J-41											●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●[2]	●				●[5]			●[6]						●[7]			●	●		
	Space Station Control Center	J-42											●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●[13]	●							●[6]								●	●		
	Systems Ops. Development Lab	J-43												●									●					●	●																●	
	Multi-systems Integration Facility	J-44		●		●	●	●		●			●		●	●		●	●	●	●	●	●	●				●				●[5]		●[5]			●[6]							●	●	●	●		
	SSE Development Facility	J-45																					●	●		●		●																	●	
GSFC	CDOF/Platform Control Center	G-01																																●[13]												
	CDOF/ESC - APAE	G-02																												●														●		
	CDOF/ESC - Platforms	G-03																																										●		
	Instrument Thermal Test Bed	G-04																												●			●											●		
	SSDIF/ITVF (RASSF) FTS/Servicing	G-05																												●	●	●												●		
	SSDIF/Integrated Logistics Support Sys.	G-06																												●	●	●	●													
	SSDIF/ITVF - APAE	G-07																										●[9]		●														●		
	SSDIF/ITVF - Platforms	G-08																										●[9]				●	●											●		
	CDOF/Software Production Facility	G-09																												●	●	●	●											●		
	Flight Dynamics Facility	G-10																												●		●												●		
	Development Integ. & Test Facility	G-11																													●[14]	●												●		
	Development, Test & Evaluation Facility	G-12																													●[14]															
	SSDIF/ITVF - FTS	G-13																										●[9]			●													●		●
	CDOF/ESC - Robotics	G-14																													●													●		
	Platform Data Mgt. System Test Bed	G-15																														●												●		
LERC	Environmental Chamber B-2, Plum Brook	Le-01																																		●										
	Environmental Chambers - Tanks 5&6	Le-02																																		●	●								●	
	PMAD System Test Bed	Le-03																																		●[4]	●						●[7]	●[7]			●	
	Space Pwr. 20 KHz Test Bed Facility	Le-04																																		●[4]											
	Power Systems Facility	Le-05					●[8]	●[8]	●[8]						●[9]								●[5]												●[4]	●							●	●	●	●		
	Nickel-Hydrogen Cell Test Bed	Le-06																																		●										
	Electric Pwr. Sys. Simulation Lab	Le-07																																		●	●								●	
	Space Power Facility - Plum Brook	Le-08																																		●									●	
	Engineering Support Center	Le-09																																		●[5]	●									
KSC	Polar Platform Processing Facility	K-01A																			●[9]	●[9]		●[9]												●[5]		●[6]		●					●	●	●	
	Polar Platform Hazardous Processing Fac	K-01B																																		●[5]				●						
	Space Station Hazardous Processing Fac	K-03					●									●																						●								
	Space Station Logistics Facility	K-04																													●[5]							●								
	Modifications for Space Station Logistics	K-05																																				●								
	Space Station Processing Facility	K-06					●	●	●				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●			●			●		●	●	●	●		
	Software Production Facility	K-07																																				●								
LARC	SS Technology Discipline Ops. Center	La-01																																					●								
	Payload Accom. Assessment Facility	La-03																																					●	●[15]								
	Materials Testing Laboratory	La-04													●[9]																													●				
	Rotary Joint Fluid Transfer Test Bed	La-05													●[9]																													●				
	Structures Laboratory	La-06																																						●[15]							●	●
	Robotics Laboratory	La-07																																						●[15]							●	●
JPL	Controls and Robotics Laboratory	JPL-01																																		●[5]					●					●	●
ARC	Neutral Buoyancy Test Facility	A-01																																								●				
	Automation Sciences Research Facility	A-02																																		●[5]		●[6]				●	●			●	
	Human-Interactive Systems Test Bed	A-03																																								●				

COMMENTS

1. Training for Payload Crew, POIC Personnel, Experimenters, and Users. M-08 reconfigured after each flight increment.
2. Training for Crew Members and Ground Support personnel:
   - distributed systems management
   - operations scenarios
   - proximity operations
   - workstation applications
   - integrated S.S. Freedom training for systems and payloads
3. Resource node shell, airlock and manned systems components provided by MSFC.
4. M-17 limited to testing electrical power system components for distribution, management, and interfacing of 20KHz electrical power throughout a module. Le-03 and Le-04 used for developing, testing, and demonstrating an integrated PMAD system. Le-05 used for end-to-end testing of the electrical power system; including the use of thermal, GN&C, DMS, OMS, and propulsion subsystem simulators. J-20 supports JSC's DMS/EPS interface development and generation of OMS operational procedures.
5. Use of facility requested by GSFC.
6. Use of facility requested by LeRC.
7. Use of this facility is requested by ARC to complete an on-going OAST project to develop and demonstrate automation technologies applicable to the Space Station Freedom.
8. Use of facility requested by MSFC.
9. Use of facility requested by JSC.
10. EVA Test Bed program utilizes J-04, J-05, and J-06.
11. Thermal Systems Test Bed program utilizes J-04 and J-05.
12. J-22 is a test facility - - not the test article - - which supports:
    - definition of functional partitioning between subsystems
    - definition of preliminary DMS service requirements
    - generation of user interface policies and guidelines
    - definition of requirements for subsystem standard data processor
13. M-06 provides integration of user payload operations activities into the manned base; serves as the focal point for the distributed user operations facilities to develop an integrated user operations execution plan. J-42 provides centralized systems management and control for the manned base, approves the integrated plan for users and systems activities, and ensures that safety requirements are met. G-01 supports the planning and controlling of platform payload operations, including platform transfer operations to meet service objectives. G-01 may have interfaces with other platform user operations centers and facilities.
14. G-11 supports engineering analysis and simulations, test and verification of telerobotic components, evaluation and integration of technology elements, development and testing of operational scenarios, and integration of demonstration flight test system. G-12 provides thermal vacuum, RFI/EMI, vibration and static load test facilities for evaluating demonstration flight test equipment.
15. Some Level I funding provided for this activity.
16. The Manned Systems Integration Test Bed consists of J-38, J-39, and J-40.

ABBREVIATIONS/ACRONYMS:

ACCOM	-	Accommodation
AC & S	-	Attitude Control & Stabilization
ADV	-	Advanced
APAE	-	Attached Payload Accommodations Equipment
ASSEM	-	Assembly
ASSY	-	Assembly
ATTCH	-	Attached
BLDG	-	Building
C & T	-	Communication & Tracking
CDOF	-	Customer Data Operations Facility
CH	-	Chamber (s)
CNTR	-	Center
COMP	-	Components
DEF	-	Definition
DETERIOR	-	Deterioration
DEV	-	Development
DIST	-	Distribution
DMS	-	Data Management System
ECLSS	-	Environmental Control & Life Support System
ELECT	-	Electrical
EMI	-	Electromagnetic Interference
EPS	-	Electrical Power System
EQUIP	-	Equipment
ESC	-	Engineering Support Center
EVA	-	Extra-vehicular Activity
EVAL	-	Evaluation
EXT	-	External
FAC	-	Facility
FLT	-	Flight
FTS	-	Flight Telerobotic Servicer
GN & C	-	Guidance, Navigation & Control
HAB	-	Habitation
INT	-	Integration
INTEG	-	Integration
ITVF	-	Integration, Test & Verification Facility
KHz	-	Kilohertz
LAB	-	Laboratory
MAT	-	Materials
MGT	-	Management
MNT	-	Maintenance
OMS	-	Operations Management System
OPS	-	Operations
OMV	-	Orbital Maneuvering Vehicle
PMAD	-	Power Management and Distribution
POIC	-	Payload Operations Integration Center
PV	-	Photovoltaic
PWR	-	Power
QUAL	-	Qualification
R & T	-	Research & Technology
RASSF	-	Robotics Assembly & Servicing Simulation Facility
RFI	-	Radio Frequency Interference
SSAIAF	-	Space Systems Automated Integration & Assembly Facility
SSDIF	-	Spacecraft Systems Development & Integration Facility
SSE	-	Software Support Environment
SERV	-	Servicing
SES	-	Systems Engineering Simulator
SIM	-	Simulation
SUP	-	Support
SYS	-	Systems
TB	-	Test Bed
TCS	-	Thermal Control System
TDRSS	-	Tracking and Data Relay Satellite System
TMIS	-	Technical Management Information System
VAC	-	Vacuum
VER	-	Verification
VERIF	-	Verification
WSTF	-	White Sands Test Facility

CENTERS:

MSFC	-	Marshall Space Flight Center
JSC	-	Johnson Space Center
GSFC	-	Goddard Space Flight Center
LERC	-	Lewis Research Center
KSC	-	Kennedy Space Center
LARC	-	Langley Research Center
JPL	-	Jet Propulsion Laboratory
ARC	-	Ames Research Center

● Facility is being proposed to support the indicated role or responsibility. NASA facilities identified for use by the prime contractors are specified in the "Contractor Required" column.

Identification of a facility at a Center that may be used in support of another Center or its prime contractor does not imply the existence of a formal agreement for use of that facility.

Level I funding that is associated with Space Station Freedom facilities is identified in the "Level I Advanced Development" column.

FIGURE 3

SPACE STATION FREEDOM FUNCTIONS versus FACILITIES

CENTER	FACILITIES	CODE	Payload Planning/Ops.	Payload Crew Training	Payload Analytical Int.	Customer Serv. & Assy.	Crew Training	Flight Crew Health Ops.	Mission Planning/Ops.	Platform Planning/Ops.	Prelaunch/Postlanding Ops.	Assembly & Ext. Sys. Mnt.	Logistics Support	Telerobotics R&T	Automation R & T	Human Factors R & T	Evolutionary Definition	Hab Module	Lab Module	PV Module	Solar Dynamic Module	Resource Nodes	Logistics Elements	Platforms	Flt.Telerobotic Servicer	Attch Payload Accom & Equip	Mobile Transporter	Truss Structure	Berthing/Docking	Airlocks	Internal TCS	External TCS	Internal Audio/Video	C & T System	GN & C System	Propulsion System	PMAD System	ECLSS	EVA Systems	Manned Systems	DMS
			FUNCTIONS															ELEMENT DEVELOPMENT													SYSTEMS DEVELOPMENT										
MSFC	WP-01 Manufacturing & Assembly Bldg.	M-01	●															●	●			●3	●							●3	●		●					●3		●3	
	Core Module Integration Facility	M-02																M	M			M	M							●	T		●				T			●	
	Process Materials Management System	M-03																	●																			T				
	Materials Compatibility Lab	M-04																	●																							
	Systems Engineering & Dev. Facility	M-05	●	●														●	●			●	●							●	●		●				●				
	Payload Operations Integration Center	M-06	●1 3	●																																					
	Engineering Support Center	M-07																●	●			●	●							●	●		●				●		●		
	Payload Operations Training Facility	M-08		●1															M			M	M														S				
	One-g Mock-up	M-09																M	M			M	M							●									●		
	Neutral Buoyancy Simulator Facility	M-10				●5												●	●		●6	●	●	●5																	
	Mechanisms Test Bed	M-14																●	●			●							T	●											
	Robotics Facility (Flat Floor)	M-15												●				●	●			●		●5	●5				S	●											
	Audio/Video/DMS Breadboard	M-16																●	●			●	●										●								
	Electrical Systems Breadboard	M-17													●7	●7		●4	●4			●4	●4								●		●								
	Dynamics Test Facility	M-18																●	●			●	●	●5						●											
	Structural Test Facility	M-19																●	●			●	●							●											
	Combined Environmental Effects Facility	M-20																●	●			●	●							●											
	Contamination Eval. & Mat. Quality Fac.	M-21																●	●			●	●							●											
	Lubricants Evaluation Facility	M-22																●	●			●	●							●											
	Materials Combustion Deterior. Test Fac.	M-23																●	●			●	●							●											
	Composites Technology Dev. Facility	M-24																●	●			●	●							●											
	Repair Technology Dev. Facility	M-25																●	●			●	●							●											
	Atomic Oxygen Test Facility	M-26																●	●			●	●							●											
	Meteoroid/Debris Protection Test Facility	M-27																●	●			●9	●					●9		●9											
	Non-destructive Eval. (NDE) Facility	M-28																●	●			●	●							●											
JSC	GN & C Emulator Test Bed	J-01						●									●																		T	S					
	EVA Test Bed	J-02				●		●			●						●							●5						●								●10		●	
	Thermal Systems Test Bed	J-03				●		●							●7		●					●		●5		●		●				●11							●	●	
	Large Man-rated Thermal Vac. Ch. A & B	J-04				●		●			●				●7		●				●	●				●		●	●	●		●							●	●	
	Small Unmanned Thermal Vac. Ch.	J-05																														●							●		
	Manned Vacuum Chambers (Bldg. 7)	J-06				●		●								●7														●							●8	●	●		
	Addition Antenna & Tracking Dev. Lab	J-07						●																					●						●	●			●		
	Tracking Systems Test Bed	J-08																											●						T	●			●		
	Anechoic Ch./Near Field Antenna Fac.	J-09						●																											●	●			●		
	Radio Frequency Communications Lab	J-10																																	T				●		
	Electromagnetic Interference Test Fac.	J-11																																	●				●		
	Communications Systems Sim. Lab	J-12																																	S				●		
	Electronic Systems Test Laboratory	J-13						●			●																		●						T						
	Flight Telecommunications Dev. Facility	J-14																																	T						
	C&T Control & Monitoring Sys. Test Bed	J-15																				●		●5						●						T				●		●
	Space Systems Auto Integ & Assem Fac	J-16						●			●							●	●	●		●	●	●5	●	●		M	●													
	Advanced Systems Development Lab	J-17																						●5		●		●							●	●	●				●	●
	SES Station On-orbit Simulator	J-18				●		●			●													S5		S		S	S	S					S	S	S			S	S	S
	Engineering Computation Fac.-C830&840	J-19																										●								●					●
	Elect. Pwr. Dist. & Control Lab/Test Bed	J-20																																							T4
	AC&S Test Bed	J-21															●											●	●							T	●					
	Data Management System Test Bed	J-22						●							●7									●5		●5															T12
	Avionics Engineering Lab	J-23						●																												●						
	WSTF Propulsion Test Area	J-24A																																		●						
	WSTF Materials Laboratory	J-24B																										●														
	Thermochemical Test Area	J-25																																		●						
	Materials Technology Labs	J-26																				●				●	●	●	●				●		●				●		●
	Structures Test Lab	J-27																								●	●	●	●												
	Dynamic Structural Testing	J-28																				●				●	●	●	●												
	Medical Operations & Research Bldg	J-29				●	●																																	●	
	Hypervelocity Test Facility	J-31																●	●			●	●					●		●			●			●			●		
	Human Computer Interaction Lab	J-32				●									●		●	●						●											●				●	●	●
	Lighting Lab	J-33						●			●				●		●	●				●		●															●	●	
	Anthropometric Biomechanics Lab	J-34															●																						●	●	
	Man-systems Telerobotics Lab	J-35				●		●			●		●				●							●5																●	
	Graphics Analysis Facility	J-36	●			●5		●			●						●	●						●5		●	●	●	●										●	●	
	Food Systems Engineering Facility	J-37				●	●	●									●																							●	
	Neutral Buoyancy Lab	J-38		●		●	●				●						●	M	M	●6	M	M	M	●5	M5	●5	M	M	M	M									S	T16		
	Space Station Mock-up & Trainer Facility	J-39				●	●	●			●						●	M	M		M	M	M	●5	M5	●5	M	M	M	M			S						●	T16	●
	Weightless Environment Training Facility	J-40				●5	●				●						●7			●6	S	M		●5	M5	●5		M	M	M									S	T16		
	Space Station Training Facility	J-41		●			●2										●7	S	S	●6	S	S			●5	S	S			●	S	S	S	S	S	S	S	S		M	S
	Space Station Control Center	J-42		●			●		●13			●								●6												●		●	●	●	●	●	●	●	●
	Systems Ops. Development Lab	J-43					●		●																					●											●
	Multi-systems Integration Facility	J-44							●															●5	●5							●	●	●	●	●	●6	●	●	●	●
	SSE Development Facility	J-45							●																										●	●					●
GSFC	CDOF/Platform Control Center	G-01							●13															●	●																
	CDOF/ESC - APAE	G-02																									●														
	CDOF/ESC - Platforms	G-03							●																																
	Instrument Thermal Test Bed	G-04																						T		T															
	SSDIF/ITVF (RASSF) FTS/Servicing	G-05				●																		●		●															
	SSDIF/Integrated Logistics Support Sys.	G-06				●																		●		●															
	SSDIF/ITVF - APAE	G-07					●9																			●															
	SSDIF/ITVF - Platforms	G-08					●9		●															●																	
	CDOF/Software Production Facility	G-09							●															●		●															
	Flight Dynamics Facility	G-10																						●		●															
	Development Integ. & Test Facility	G-11																	M					●		●14															
	Development, Test & Evaluation Facility	G-12																								●14															
	SSDIF/ITVF - FTS	G-13					●9							●												●															
	CDOF/ESC-Robotics	G-14																						●																	
	Platform Data Mgt. System Test Bed	G-15																						T																	
LERC	Environmental Chamber B-2, Plum Brook	Le-01																			S																				
	Environmental Chambers - Tanks 5&6	Le-02																			S	S																			
	PMAD System Test Bed	Le-03													●7	●7																						T4			
	Space Pwr. 20 KHz Test Bed Facility	Le-04																																		T4				
	Power Systems Facility	Le-05																●8	●8				●8	●5												T4				
	Nickel-Hydrogen Cell Test Bed	Le-06																			T																				
	Electric Pwr. Sys. Simulation Lab	Le-07																			S															S					
	Space Power Facility - Plum Brook	Le-08																			S																				
	Engineering Support Center	Le-09																						●5												●						
KSC	Polar Platform Processing Facility	K-01A								●														●5									●9	●9		●6				●9	
	Polar Platform Hazardous Processing Fac	K-01B								●														●5																	
	Space Station Hazardous Processing Fac	K-03								●																										●						
	Space Station Logistics Facility	K-04				●5						●																													
	Modifications for Space Station Logistics	K-05										●																													
	Space Station Processing Facility	K-06								●	●							●	●	●		●	●		●	●	●	●	●				●	●	●	●	●		●		●
	Software Production Facility	K-07								●																										●						
LARC	SS Technology Discipline Ops. Center	La-01	●																																						
	Payload Accom. Assessment Facility	La-03	●		●												●15																								
	Materials Testing Laboratory	La-04																											●9			●9								
	Rotary Joint Fluid Transfer Test Bed	La-05																											T9			T9								
	Structures Laboratory	La-06													●15	●15	●15																								
	Robotics Laboratory	La-07													●15	●15	●15							●15																	
JPL	Controls and Robotics Laboratory	JPL-01													●									●5																	
ARC	Neutral Buoyancy Test Facility	A-01															●																							S	
	Automation Sciences Research Facility	A-02													●	●	●							●5												●6					
	Human-Interactive Systems Test Bed	A-03															●																								

COMMENTS

1. Training for Payload Crew, POIC Personnel, Experimenters, and Users. M-08 reconfigured after each flight increment.
2. Training for Crew Members and Ground Support personnel:
   - distributed systems management
   - operations scenarios
   - proximity operations
   - workstation applications
   - integrated S.S. Freedom training for systems and payloads
3. Resource node shell, airlock and manned systems components provided by MSFC.
4. M-17 limited to testing electrical power system components for distribution, management, and interfacing of 20KHz electrical power throughout a module. Le-03 and Le-04 used for developing, testing, and demonstrating an integrated PMAD system. Le-05 used for end-to-end testing of the electrical power system; including the use of thermal, GN&C, DMS, OMS, and propulsion subsystem simulators. J-20 supports JSC's DMS/EPS interface development and generation of OMS operational procedures.
5. Use of facility requested by GSFC.
6. Use of facility requested by LeRC.
7. Use of this facility is requested by ARC to complete an on-going OAST project to develop and demonstrate automation technologies applicable to the Space Station Freedom.
8. Use of facility requested by MSFC.
9. Use of facility requested by JSC.
10. EVA Test Bed program utilizes J-04, J-05, and J-06.
11. Thermal Systems Test Bed program utilizes J-04 and J-05.
12. J-22 is a test facility - - not the test article - - which supports:
    - definition of functional partitioning between subsystems
    - definition of preliminary DMS service requirements
    - generation of user interface policies and guidelines
    - definition of requirements for subsystem standard data processor
13. M-06 provides integration of user payload operations activities into the manned base; serves as the focal point for the distributed user operations facilities to develop an integrated user operations execution plan. J-42 provides centralized systems management and control for the manned base, approves the integrated plan for users and systems activities, and ensures that safety requirements are met. G-01 supports the planning and controlling of platform payload operations, including platform transfer operations to meet service objectives. G-01 may have interfaces with other platform user operations centers and facilities.
14. G-11 supports engineering analysis and simulations, test and verification of telerobotic components, evaluation and integration of technology elements, development and testing of operational scenarios, and integration of demonstration flight test system. G-12 provides thermal vacuum, RFI/EMI, vibration and static load test facilities for evaluating demonstration flight test equipment.
15. Some Level I funding provided for this activity.
16. The Manned Systems Integration Test Bed consists of J-38, J-39, and J-40.

ABBREVIATIONS/ACRONYMS:

ACCOM	-	Accommodation
AC & S	-	Attitude Control & Stabilization
ADV	-	Advanced
APAE	-	Attached Payload Accommodations Equipment
ASSEM	-	Assembly
ASSY	-	Assembly
ATTCH	-	Attached
BLDG	-	Building
C & T	-	Communication & Tracking
CDOF	-	Customer Data Operations Facility
CH	-	Chamber (S)
CNTR	-	Center
COMP	-	Components
DEF	-	Definition
DETERIOR	-	Deterioration
DEV	-	Development
DIST	-	Distribution
DMS	-	Data Management System
ECLSS	-	Environmental Control & Life Support System
ELECT	-	Electrical
EMI	-	Electromagnetic Interference
EPS	-	Electrical Power System
EQUIP	-	Equipment
ESC	-	Engineering Support Center
EVA	-	Extra-vehicular Activity
EVAL	-	Evaluation
EXT	-	External
FAC	-	Facility
FLT	-	Flight
FTS	-	Flight Telerobotic Servicer
GN & C	-	Guidance, Navigation & Control
HAB	-	Habitation
INT	-	Integration
INTEG	-	Integration
ITVF	-	Integration, Test & Verification Facility
KHz	-	Kilohertz
LAB	-	Laboratory
MAT	-	Materials
MGT	-	Management
MNT	-	Maintenance
OMS	-	Operations Management System
OPS	-	Operations
OMV	-	Orbital Maneuvering Vehicle
PMAD	-	Power Management and Distribution
POIC	-	Payload Operations Integration Center
PV	-	Photovoltaic
PWR	-	Power
QUAL	-	Qualification
R & T	-	Research & Technology
RASSF	-	Robotics Assembly & Servicing Simulation Facility
RFI	-	Radio Frequency Interference
SSAIAF	-	Space Systems Automated Integration & Assembly Facility
SSDIF	-	Spacecraft Systems Development & Integration Facility
SSE	-	Software Support Environment
SERV	-	Servicing
SES	-	Systems Engineering Simulator
SIM	-	Simulation
SUP	-	Support
SYS	-	Systems
TB	-	Test Bed
TCS	-	Thermal Control System
TDRSS	-	Tracking and Data Relay Satellite System
TMIS	-	Technical Management Information System
VAC	-	Vacuum
VER	-	Verification
VERIF	-	Verification
WSTF	-	White Sands Test Facility

CENTERS :

MSFC	-	Marshall Space Flight Center
JSC	-	Johnson Space Center
GSFC	-	Goddard Space Flight Center
LERC	-	Lewis Research Center
KSC	-	Kennedy Space Center
LARC	-	Langley Research Center
JPL	-	Jet Propulsion Laboratory
ARC	-	Ames Research Center

● Facility is being proposed to support the indicated Function, Hardware, or System. Support may be in one of the following forms:

M = Mock-up : A physical type simulator varying from low fidelity volumetric models for development purposes to high fidelity flight-like representations used for crew training and mission support.

S = Simulator : A facility, device, and/or software that allows tests and training to be completed in the absence of the actual interfacing hardware, software, or environment.
- o Physical - Capability to verify physical mating or installation.
- o Functional - Capability to show exchange of resources.
- o Environmental - Capability to test for environment compatibility
  - Acoustic, Vibration, Shock
  - Contamination
  - Thermal
  - Low Gravity
  - Electromagnetic

T = Test Bed : A facility for integrating and testing prototype technology hardware and/or software at the system or component level. The facility includes the necessary instrumentation tools, simulators, and support software.

Identification of a facility at a Center that may be used in support of another or its Prime Contractor does not imply the existence of a formal agreement for the use of that facility.

FIGURE 4

V. CONSTRUCTION OF FACILITIES

The facilities reviewed by the FRP that require Construction of Facilities (CoF) funding are shown in the tabulation in Figure 5. The facilities are listed by Center without regard to priority or approval status. The tabulation shows the project funding requirements by fiscal year for each of the Centers. The facility projects range from large discrete projects that require the building of major new facilities to minor projects which involve the modification of existing facilities. Some have been funded, while others are in the current CoF budget review process or in the CoF Five-Year Plan.

PRECEDING PAGE BLANK NOT FILMED

PAGE 26 INTENTIONALLY BLANK

FACILITY ID NO	PROJECT	FISCAL YEAR ($000) 87	88	89	90	91	92	93	94	95
A-01	NEUTRAL BUOYANCY TEST FACILITY						500			
A-02	AUTOMATION SCIENCES RESEARCH FAC.				10,600		750			
G-A	CUSTOMER DATA OPS FACILITY				12,000					
G-01	PLATFORM CONTROL CENTER						(1)			
G-02	CDOF/ESC-ATTACH PAYLOAD ACCOM EQUIP						(1)			
G-03	CDOF/ESC-PLATFORMS						(1)			
G-09	CDOF/SOFTWARE PRODUCTION FACILITY						(1)			
G-14	CDOF/ESC-ROBOTICS						(1)			
G-B	SPACECRAFT SYS. DEV. & INTEG. FAC.	8,000	8,600							
G-07	SSDIF/ITVF-APAE									(2)
G-08	SSDIF/ITVF-PLATFORMS									(2)
G-05	ROBOTICS ASSEM & SERV SIMUL. FAC.				730					
G-11	DEVELOPMENT INTEG & TEST FACILITY					3,500				
J-03	THERMAL SYSTEMS TEST BED				380					
J-04	LG MAN-RATED THERMAL VACUUM CH			580	2,000	900	470			
J-05	SM UNMANNED THERMAL VACUUM CH								600	
J-06	MANNED VACUUM CHAMBERS				720					
J-07	ADD TO ANT. & TRACKING DEV. LAB				1,800					
J-09	ANECHOIC CH./NEAR FIELD ANT.	725								
J-13	ELECTRONIC SYSTEMS TEST LAB				450					
J-16	SPACE SYS AUTO INTEG. & ASSY FAC				10,500					
J-17	ADV SYS DEVELOPMENT LAB.			700						
J-18	SES STATION/ON-ORBIT SIMULATOR	700	720			1,500				
J-19	ENGINEERING COMPUTATION FAC					600	400			
J-22	DATA MANAGEMENT SYS TEST BED	(3)								
J-23	AVIONICS ENGINEERING LAB.	(3)								
J-29	MEDICAL OPS & RESEARCH BLDG				12,800					
J-38	NEUTRAL BUOYANCY LAB				30,000					
J-39	SS MOCK-UP AND TRAINER FAC	5,000								

(1) MODIFICATIONS/OUTFITTING OF THE CDOF (G-A)
(2) MODIFICATIONS/OUTFITTING OF THE SSDIF (G-B)
(3) INCLUDED IN $700K PROJECT FOR LAB MODS

FIGURE 5 SPACE STATION FREEDOM CoF PROGRAM PLAN

FACILITY ID NO.	PROJECT	FISCAL YEAR ($000) 87	88	89	90	91	92	93	94	95
J-41	SS TRAINING FACILITY				3,800					
J-42	SS CONTROL CENTER				17,800		5,000			
J-44	MULTI-SYSTEMS INTEG FAC	(4)								
J-45	SSE DEVELOPMENT FACILITY	(4)								
JPL-01	CONTROLS AND ROBOTICS					14,600				
K-01	SS POLAR PLATFORM FAC						5,900			
K-03	SS HAZARDOUS PROCESSING FAC					1,800				
K-04	SS LOGISTICS FACILITY						36,900			
K-05	MODS FOR SS LOGISTICS				1,210					
K-06	SS PROCESSING FACILITY				43,000	41,000(5)				
La-01	TECHNOLOGY DISCIPLINE OPS CTR						4,500			
Le-05	POWER SYSTEMS FACILITY	6,100								
Le-08	SPACE POWER FACILITY-PLUM BROOK					680				
Le-09	ENGINEERING SUPPORT CENTER					2,700				
M-02	CORE MODULE INTEGRATION FAC	740		638						
M-05	SYSTEMS ENG & DEVELOPMENT FAC				7,000					
M-09	ONE-G MOCK-UP	299								
M-14	MECHANISMS TEST BED		178							
M-15	ROBOTICS FACILITY (FLAT FLOOR)		673							
M-17	ELECTRICAL SYS BREADBOARD	250								
M-20	COMBINED ENVIRO EFFECTS FAC	740								
M-24	COMPOSITES TECHNOLOGY DEV FAC					888				
M-25	REPAIR TECHNOLOGY DEV FAC				4,000					
	TOTAL	22,554	10,171	1,918	158,790	68,168	54,420	0	600	0

(4) INCLUDED IN CENTRAL COMPUTING FACILITY ($9,000)
(5) PRIVATE SECTOR FINANCING UNDER CONSIDERATION

FIGURE 5 SPACE STATION FREEDOM CoF PROGRAM PLAN (Continued)

VI. OBSERVATIONS

During the FRP activities, it was observed that communications between Centers regarding the utilization of facilities was in the very preliminary stages. Additional definition/coordination is needed for negotiations between the various work package contractors and the Centers in order to conduct the necessary facility loading analyses. The FRP believes that this Report can serve to identify those facilities that support more than one Center, and foster the exchange of information pertaining to facility requirements. The Centers are encouraged to enter into Memoranda of Understanding that would govern facility usage and inhibit any schedule or funding delays.

This review of NASA facilities only begins to put the complete facility picture in perspective. The FRP deliberately omitted commercial, university, contractor and international partner facilities from the review process. The FRP believes that there is a great deal to be gained by examining those facilities, especially those of the work package contractors, where the sudden loss of a facility could leave the program without a needed capability. In addition, facilities associated with the Science and Technology Centers should be scrutinized to ensure that the proper program interfaces are provided. The FRP suggests that its initial work be continued and that other facilities intended for use by the program be integrated into the facility planning process.

The FRP identified a need for a plan that describes when the use of a facility by the Space Station Freedom program is phased in and/or out. A plan of this type would feature several elements: development phase facilities that are required to support subsequent operations, the impact of cost sharing with other NASA organizations (e.g., what happens if co-funding support ends?), projected funding by fiscal year, and the approximate dates when the use of specific facilities may be completely phased out. The dates for operational readiness and phase-out would be based upon First Element Launch, since this milestone is unique and can function as a convenient reference point from which to base other date calculations. Operations facilities would be thoroughly covered because their development must begin well in advance of First Element Launch. The FRP recognizes the difficulty of establishing a phasing plan and suggests that appropriate measures be taken to bring such a plan to fruition.

This report should act as an aid for the Space Station Freedom management evaluation of facilities and their requirements, and as a basis for developing a set of facility catalogs. The catalogs should be organized by Center and describe the unique features and capabilities of each facility. They will also be an ideal medium for disseminating facility data to the experimenters and payload developers. Control of the catalogs will be defined in a Facilities Management Plan that will be issued and maintained by Level II.

The FRP participants agree that the facilities review and, in particular, the outstanding presentation materials and briefings received at each Center, enhanced their understanding of the program, encouraged dialogue between the Centers, and provided an excellent foundation for building a long-term facilities management program. The program participants are encouraged to use this report and the detailed charts enclosed to assist them in the difficult task ahead of making Space Station Freedom operational.

VII. APPENDIX

FACILITIES CODE INDEX

CODE	PAGE	CODE	PAGE	CODE	PAGE
A-01	14	J-21	6	La-06	14
A-02	18	J-22	7	La-07	18
A-03	17	J-23	12		
		J-24A	12	Le-01	13
G-01	21	J-24B	20	Le-02	13
G-02	21	J-25	12	Le-03	13
G-03	21	J-26	20	Le-04	14
G-04	12	J-27	12	Le-05	14
G-05	16	J-28	12	Le-06	14
G-06	21	J-29	16	Le-07	7
G-07	13	J-31	20	Le-08	14
G-08	13	J-32	16	Le-09	21
G-09	7	J-33	16		
G-10	21	J-34	17	M-01	8
G-11	17	J-35	17	M-02	8
G-12	13	J-36	12	M-03	8
G-13	18	J-37	12	M-04	18
G-14	21	J-38	15	M-05	20
G-15	7	J-39	15	M-06	20
		J-40	16	M-07	20
J-01	9	J-41	16	M-08	15
J-02	9	J-42	21	M-09	15
J-03	9	J-43	7	M-10	15
J-04	10	J-44	7	M-14	8
J-05	10	J-45	7	M-15	17
J-06	10			M-16	8
J-07	10	JPL-01	18	M-17	9
J-08	10			M-18	9
J-09	10	K-01A	21	M-19	9
J-10	10	K-01B	22	M-20	18
J-11	11	K-03	22	M-21	19
J-12	15	K-04	22	M-22	19
J-13	11	K-05	22	M-23	19
J-14	11	K-06	22	M-24	19
J-15	11	K-07	8	M-25	9
J-16	11			M-26	19
J-17	17	La-01	22	M-27	19
J-18	15	La-03	16	M-28	19
J-19	6	La-04	20		
J-20	11	La-05	14		

PAGE 32 INTENTIONALLY BLANK

PRECEDING PAGE BLANK NOT FILMED